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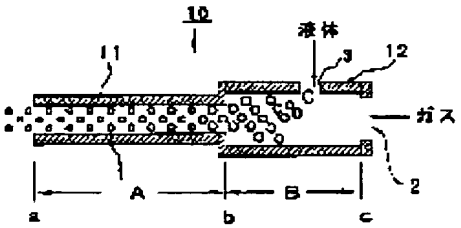
(54) BINARY FLUID JET NOZZLE FOR WASHING AND WASHING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To strongly remove a minute foreign matter stuck to the substrate of a semiconductor without damaging the substrate.
SOLUTION: The binary fluid jet nozzle for washing is used to wash a foreign matter stuck to the surface of the substrate of a semiconductor. The cross-sectional area of a gas flow path in a mixing part, in which droplets are formed by mixing liquid with pressurized gas, is formed larger than the cross-sectional area of the flow path of an accelerating tube for accelerating droplets together with gas to inject them into the air. For example, the gas flow path is formed into the shape of a straight pipe in which its length is 30-200mm and the cross- sectional area of the inside is ≥3mm2. Further, the accelerating tube is formed into the shape of a circular straight pipe or the shape of de Laval nozzle.



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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] 2 fluid jet nozzle for washing characterized by having had the mixed section which mixes the gas and the liquid which were pressurized and forms a drop, and the acceleration tube section which injects said drop in mind, and forming more greatly than the cross section of the minimum part of the circulation way of said acceleration tube section the cross section of the minimum part of the circulation way of said gas of said mixed section.
[Claim 2] 2 fluid jet nozzle for washing according to claim 1 to which a form is characterized by being a circular straight pipe among said acceleration tube sections.
[Claim 3] 2 fluid jet nozzle for washing according to claim 1 or 2 to which the die length is characterized by the cross section in 30-200mm and tubing making said acceleration tube section 3mm straight pipe configuration it is [configuration] two or more.
[Claim 4] Said acceleration tube section is 2 fluid jet nozzle for washing according to claim 1 to which the bore is characterized by considering as the Laval-nozzle configuration which becomes large gradually toward the jet direction of said drop from a connection side with said mixed section.
[Claim 5] For the cross-sectional area in 30-200mm and tubing, die length is [said acceleration tube section] 2 fluid jet nozzle for washing according to claim 4 to which it is characterized by carrying out to two or more [3mm] with a converging section.
[Claim 6] 2 fluid jet nozzle for washing given in claim 1 characterized by making the configuration of said mixed section cylindrical thru/or any 1 term of 5.
[Claim 7] Said mixed section is 2 fluid jet nozzle for washing given in claim 1 characterized by forming so that the cross section may be gradually reduced in the direction linked to said acceleration tube section thru/or any 1 term of 5.
[Claim 8] Said mixed section is 2 fluid jet nozzle for washing given in claim 1 characterized by having the 1st duct through which said gas passes, and the 2nd duct which spouts said liquid in the passage direction of said gas in this 1st duct thru/or any 1 term of 7.
[Claim 9] Said mixed section is 2 fluid jet nozzle for washing given in claim 1 characterized by having the 1st duct through which gas passes, the 2nd duct which is arranged into this 1st duct and spouts said liquid, and the 3rd duct which is arranged into this 2nd duct and spouts gas further thru/or any 1 term of 7.
[Claim 10] The direction of the liquid which blows off from the gas which flows said 1st duct, and the 2nd duct is 2 fluid jet nozzle for washing according to claim 8 or 9 characterized by being the same as that of the jet direction of said drop.
[Claim 11] 2 fluid jet nozzle for washing given in claim 1 characterized by forming more greatly than the cross section of said acceleration tube section the cross section of the gas input supplied to said mixed section thru/or any 1 term of 10.
[Claim 12] 2 fluid jet nozzle for washing given in claim 1 characterized by having a straightening vane in the jet direction of a drop, and the direction which carries out an abbreviation rectangular cross at the point of said acceleration tube section thru/or any 1 term of 11.
[Claim 13] The washing station characterized by having 2 fluid jet nozzle for washing given in claim 1 thru/or any 1 term of 12, a gas supply means to be connected to the mixed section of

said 2 fluid jet nozzle for washing, and to supply pressurization gas, and a liquid supply means to be connected to the mixed section of said 2 fluid jet nozzle for washing, and to supply a pressurization liquid.

[Claim 14] The washing station according to claim 13 characterized by arranging the tip of the acceleration tube section of said 2 fluid jet nozzle for washing in the location distant from the washed material front face 5-50mm.

[Claim 15] The washing station according to claim 13 or 14 characterized by making into 1 - 10 kgf/cm2 the supply pressure of the gas supplied to said 2 fluid jet nozzle, and a liquid, respectively.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to 2 fluid jet nozzle for washing which removes the contamination which has adhered on a semi-conductor substrate etc. in more detail about 2 fluid jet nozzle for washing. This invention relates to the washing station from which the contamination which has adhered on a substrate again using this 2 fluid jet nozzle for washing is removed.
[0002]
[Description of the Prior Art] Generally in the manufacture process of a semi-conductor, various contaminations adhere on the front face of a semi-conductor wafer. For example, if an insulator layer and a metal membrane are formed by the CVD method or the spatter on a semi-conductor wafer, a particle-like contamination will adhere to the front face. Moreover, after the pattern formation by dry etching, an etching residue (resist residue) metallurgy group contamination adheres. Washing of the drop injection using 2 fluid jet nozzle for high-pressure jet backwashing by water, ice scrubber washing, and washing as an approach of removing these contaminations is proposed from the former.
[0003] Drawing 17 is the mimetic diagram of the conventional washing station by the approach called high-pressure jet backwashing by water. In this washing station, the semi-conductor wafer 5 is held to on a stage 6, and this is rotated by the motor 7. The high-pressure jet nozzle 69 connected through piping from the pure-water pressurizer 68 is arranged to this semi-conductor wafer 5. In this washing approach, first, with the pure-water pressurizer 68, the high pressure of 50 - 100 kgf/cm2 (kg pile / cm2) is pressurized, and liquids, such as pure water, are supplied to the high-pressure jet nozzle 69 through piping. There is a hole of diameter 0.1mm extent in the high-pressure jet nozzle 69, and a liquid blows off from here to the semi-conductor wafer 5 continuously. The contamination with which the liquid which blew off has adhered to the front face of the semi-conductor wafer 5 by colliding with the front face of the semi-conductor wafer 5 is removed, and washing is performed.
[0004] The trouble of this washing approach has a low detergency, and is that particle 1 micrometer or less is fully unremovable. Although what is necessary is to pressurize a liquid more at high pressure and just to make high the spray velocity of the liquid from the high-pressure jet nozzle 69, in order to heighten a detergency, the pure-water pressurizer 68 becomes large-sized equipment, and is not a best policy economically. As an example, when the supply pressures of a liquid are 100 kgf/cm2, the spray velocity of a liquid serves as about 130 m/sec.
[0005] Drawing 18 is the sectional view of the conventional 2 fluid jet nozzle 70 for washing. 2 fluid jet nozzle 70 for washing is equipped with the 1st duct 72 where gas passes through the inside of it, and the 2nd duct 73 where the side attachment wall of the 1st duct 72 is penetrated, the point is prolonged even in the 1st duct 72 from the outside of the 1st duct 72, and a liquid passes through the inside of it. The point of the 2nd duct 73 is prolonged in the same direction as the direction where the 1st duct 72 extends.
[0006] This 2 fluid jet nozzle 70 for washing was used, for example, the mimetic diagram of the

configuration of the washing station for semi-conductor wafers is shown in drawing 19 . This washing station is equipped with a process cup 8, the stage 6 holding the semi-conductor wafer 5 in a process cup 8, the motor 7 made to rotate this stage 6, 2 fluid jet nozzle 70 for washing which turns a drop to the front face of the semi-conductor wafer 5, and is spouted, the gas-supply means 2a which supply the gas which pressurized 2 fluid jet nozzle 70 for washing, and the liquid supply means 3a which supply the liquid which pressurized 2 fluid jet nozzle 70 for washing. The exhaust port 9 is connected to the process cup 8. Moreover, 2 fluid jet nozzle 70 for washing was held, and it has the robot arm 4 to which it is made to move.

[0007] Next, actuation of this washing station is explained. The semi-conductor wafer 5 is fixed to a stage 6, and it rotates at a predetermined rotational frequency. The liquid which pressurized the gas pressurized from gas supply means 2a from liquid supply means 3a again is supplied to 2 fluid jet nozzle 70 for washing, respectively. In 2 fluid jet nozzle 70 for washing, as shown in drawing 18 , gas and a liquid are mixed, a liquid changes to the granular drop 1, and between a-b in drawing in the 1st duct 72, it is accelerated by the flow of gas and it blows off from the tip of the 1st duct 72. As shown in drawing 19 , the spouted drop 1 collides with the front face of the semi-conductor wafer 5, and removes the contamination which has adhered on the front face of the semi-conductor wafer 5. The contamination removed from the semi-conductor wafer 5, the drop 1 which dispersed after the surface collision of the semi-conductor wafer 5, and the gas which blew off from 2 fluid jet nozzle 70 for washing are discharged out of a process cup 8 from an exhaust port 9. In order to wash the whole surface of the semi-conductor wafer 5 at the time of washing, 2 fluid jet nozzle 70 for washing is held, and 2 fluid jet nozzle 70 for washing is horizontally moved along the front face of the semi-conductor wafer 5 by the robot arm 4 to which it is made to move.

[0008] This washing station has a high detergency compared with above-mentioned high-pressure jet backwashing by water. Moreover, a running cost is cheaper than the conventional ice scrubber washing. Moreover, since this washing station can control a detergency broadly, it does not have destruction of a detailed pattern and does not do damage to a metal membrane with a small degree of hardness. However, there is a trouble that a cleaning effect is low compared with ice scrubber washing. This reason is explained below.

[0009] In washing by 2 fluid jet nozzle for washing, the detergency is equivalent to the rate of a drop. The rate of a drop is determined by the flow rate of gas, the flow rate of a liquid, the distance between a-b in drawing in the 1st duct 72 of 2 fluid jet nozzle 70 for washing, and the cross section inside the 1st duct 72 in the meantime. For example, if the bore of 100mm and the 1st duct 72 is set [the flow rate of gas / the flow rate of 200 L/min and a liquid] to 4.35mm for the distance between 100 mL/min and a-b, the rate of a drop will serve as 224 m/sec. Usually, since the configuration of 2 fluid jet nozzle for washing is being fixed, although the rate of a drop is determined by the flow rate of gas, and the flow rate of a liquid, it is governed by the flow rate of gas especially with the large volume.

[0010] The 1st duct 72 is a straight pipe and the internal cross section of the 1st duct 72 of the outside of the 2nd duct 73 through which gas passes becomes smaller than the internal cross section between a-b in drawing as shown in drawing 18 . Therefore, rate-limiting [of the flow rate of gas] is carried out by the internal cross section of the 1st narrowest duct 72 of a path of the outside of the 2nd duct 73. That is, the rate is restricted. Usually, the supply pressure of gas is up to a maximum of 10 kgf/cm2, and even about two a maximum of 7 kgf/cm is especially used by the semi-conductor plant. For example, if the outer diameter of the 2nd duct 73 is set to 3.2mm, the internal cross section of the 1st duct 72 of the outside of the 2nd duct 73 where gas flows will be set to 2 6.8mm. If the supply pressure of gas is made into 7 kgf/cm2, the flow rate of gas will serve as about 200 L/min. The rate of the drop in this case serves as 224 m/sec as mentioned above.

[0011] If the part at the tip of 2 fluid jet nozzle 70 for washing makes [many] the flow rate of gas, it is fundamentally possible for the rate of the gas which flows the inside of this in the case of a straight pipe configuration like [between a-b in drawing] up to about 330 m/sec of whenever [sonic]. However, in 2 fluid jet nozzle 70 for washing of the configuration of drawing 18 , the rate of a drop does not reach to whenever [sonic] in the range to a maximum of 7

kgf/cm2 which is the supply pressure of the gas usually used. Since it depends for the detergency on the rate of a drop, the detergency of this 2 fluid jet nozzle 70 for washing is low in the supply pressure range of the gas usually used.
[0012] Although the rate of the increase of the flow rate of gas and a drop will increase if the supply pressure of gas is usually made higher than the use range, maximum is whenever [sonic] as mentioned above. Although stated later, when the collision rate of a ice grain child and a drop is the same, the ice scrubber washing of a detergency is higher at the ice grain child in ice scrubber washing, and the drop in this washing by the difference in the physical-properties value of ice and liquid (for example, water). In ice scrubber washing, since a ice grain child's rate can be reached to whenever [maximum acoustic-velocity], the detergency of this 2 fluid jet nozzle 70 for washing cannot exceed ice scrubber washing.
[Problem(s) to be Solved by the Invention]
[0013] Moreover, that it is not economical since the trouble of this washing station needs to enlarge displacement of a process cup 8, and in order to fully perform exhaust air, the include angle with semi-conductor wafer 5 front face of 2 fluid jet nozzle 70 for washing is made into 60 degrees or less, and, for this reason, a detergency is that the damage control to a detailed pattern fully becomes difficult. In order that the contamination carried out - ****** from the semi-conductor wafer 5 may not carry out the reattachment to the front face of the semi-conductor wafer 5, the contamination, the drop 1, and gas which were removed must be made to discharge out of a process cup 8 from an exhaust port 9. For this reason, an exhaust port 9 is arranged in the exhaust nozzle of 2 fluid jet nozzle 70 for washing, and the location which countered, and sufficient displacement is required for it. Specifically, in the case of the washing station of drawing 19 , displacement is required more than about 5m3/min.
[0014] Moreover, when an include angle with the semi-conductor wafer 5 of 2 fluid jet nozzle 70 for washing is 60 degrees or more, it reflects on the front face of the semi-conductor wafer 5, and the jet of a drop and gas disperses upwards from up opening of a process cup 8, and makes the front face of the semi-conductor wafer 5 carry out the reattachment of the contamination. It is so high that the collision include angle of a detergency of a drop is perpendicularly near, and extent of the damage to a detailed pattern becomes so small that the collision include angle of a drop is perpendicularly near. The force (external force) which a detailed pattern receives changes, and extent of the damage to a detailed pattern changes with the collision include angles of a drop. Therefore, if a drop is spouted from across to the semi-conductor wafer 5, the difference in the collision include angle of a drop will come out on the front face of the semi-conductor wafer 5, and it will become difficult to control the damage to a detailed pattern.
[0015] Moreover, the trouble in such washing was produced when the contamination which has adhered on substrates, such as not only a semi-conductor wafer but a liquid crystal substrate, a photo mask, etc., was removed.
[0016] As mentioned above, in the conventional washing station, there was a problem that an affix with the low especially detailed detergency to a semiconductor material etc. was fully unremovable. Moreover, there was a problem that the damage to a semiconductor material etc. was fully uncontrollable.
[0017] So, the purpose of this invention is to offer 2 fluid jet nozzle for washing which removes powerfully the contamination which has adhered on front faces, such as a semi-conductor substrate, and the washing station using this. Other purposes of this invention are to offer 2 fluid jet nozzle for washing improved so that the minute foreign matter 1 micrometer or less which has adhered on a substrate etc. could be removed, and a washing station.
[0018] The purpose of further others of this invention is to offer 2 fluid jet nozzle for washing improved so that the spray velocity of a drop could exceed whenever [sonic], and a washing station. The purpose of further others of this invention is to offer the cheap washing station of a running cost.
[0019] The purpose of further others of this invention is to offer 2 fluid jet nozzle for washing improved so that the contamination which has adhered on front faces, such as a substrate, could be removed without doing damage to front faces, such as a substrate, and a washing station.
[0020]

[Means for Solving the Problem] 2 fluid jet nozzle for washing of this invention is equipped with the mixed section which mixes the gas and the liquid which were pressurized and forms a drop, and the acceleration tube section which injects said drop in mind, and is characterized by forming more greatly than the cross section of the minimum part of the circulation way of said acceleration tube section the cross section of the minimum part of the circulation way of said gas of said mixed section.
[0021] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by a form being a circular straight pipe among said acceleration tube sections.
[0022] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by the cross section in 30-200mm and tubing making [that die length] said acceleration tube section 3mm straight pipe configuration it is [configuration] two or more.
[0023] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by that bore making said acceleration tube section the Laval-nozzle configuration which becomes large gradually toward the jet direction of a connection side with said mixed section to said drop.
[0024] Moreover, as for 2 fluid jet nozzle for washing of this invention, the cross section in 30-200mm and tubing is characterized by die length making said acceleration tube section two or more [3mm] with a converging section.
[0025] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by making the configuration of said mixed section cylindrical. Moreover, 2 fluid jet nozzle for washing of this invention is characterized by forming so that the cross section may be gradually reduced in the direction which connects said mixed section with said acceleration tube section.
[0026] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by having the 1st duct where said gas passes said mixed section, and the 2nd duct which spouts said liquid in the passage direction of said gas in this 1st duct.
[0027] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by having the 1st duct where said gas passes said mixed section, the 2nd duct which is arranged into this 1st duct and spouts said liquid, and the 3rd duct which is arranged into this 2nd duct and spouts said gas further.
[0028] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by being the same as that of the jet direction of said drop in the direction of the liquid which blows off from the gas which flows said 1st duct, and the 2nd duct.
[0029] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by forming more greatly than the cross section of said acceleration tube section the cross section of the gas input supplied to said mixed section.
[0030] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by having a straightening vane in the jet direction of a drop, and the direction which carries out an abbreviation rectangular cross at the point of said acceleration tube section.
[0031] Furthermore, the washing station of this invention is characterized by having one of above-mentioned 2 fluid jet nozzles for washing, a gas supply means to be connected to the mixed section of said 2 fluid jet nozzle for washing, and to supply pressurization gas, and a liquid supply means to be connected to the mixed section of said 2 fluid jet nozzle for washing, and to supply a pressurization liquid.
[0032] Moreover, the washing station of this invention is characterized by arranging the tip of the acceleration tube section of said 2 fluid jet nozzle for washing in the location distant from the washed material front face 5-50mm.
[0033] Moreover, the washing station of this invention is characterized by making into 1 - 10 kgf/cm2 the supply pressure of the gas supplied to said 2 fluid jet nozzle, and a liquid, respectively.
[0034]
[Embodiment of the Invention] The gestalt of implementation of this invention is explained about drawing below. In addition, the same sign shows a same or considerable part through each drawing.
Gestalt 1. drawing 1 of operation is the sectional view concerning the gestalt of implementation of this invention showing the structure of 2 fluid jet nozzle 10 for washing. This injects in mind

the drop which mixed and formed the gas and the liquid which were pressurized, and washes by making it collide with a washed object front face. This 2 fluid jet nozzle 10 for washing consists of the mixed sections B which have the mixer tube 12 which mixes the acceleration section A which has the acceleration tube 11 which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of gas and the input 3 of a liquid which were pressurized are established in the mixer tube 12.

[0035] Between the acceleration tubes 11 at the tip of a nozzle where the description of this 2 fluid jet nozzle 10 for washing spouts a drop, i.e., a-b in drawing, is a circular straight pipe configuration, and die length is that the cross section in 30-200mm and tubing is 2 3-15mm. Moreover, it is a circular straight pipe configuration between the mixer tubes 12 with which the gas and the liquid which were pressurized are respectively mixed through piping, i.e., b-c in drawing, and it is that the cross section has the space of 2 [die length / 3-50mm] 7-100mm. Furthermore, the cross section of the input 2 of the gas supplied to said mixer tube 12 is that the cross section of 2 and the input 3 of a liquid is 2 0.01-20mm 7-200mm.

[0036] As a concrete example, the die length between a-b in drawing is [the cross section in 100mm and tubing] 2 7mm, as for the mixer tube 12, the die length between b-c in drawing has 30mm, the cross section has the space of 2 20mm, and the cross section of the input 2 of gas is [the cross section of the input 3 of 2 and a liquid of the acceleration tube 11 at the tip of a nozzle] 2 5mm 15mm.

[0037] Drawing 2 is the mimetic diagram in which having equipped with said 2 fluid jet nozzle 10 for washing, for example, showing the configuration of the washing station for semi-conductor wafers. This washing station removes the contamination which has adhered on the front face of the semi-conductor wafer 5. It connects with 2 fluid jet nozzle 10 for washing, and this washing station equips 2 fluid jet nozzle 10 for washing with gas supply means 2a which carries out pressurization supply of gas and the liquid, and liquid supply means 3a. Moreover, this equipment is equipped with the stage 6 holding the semi-conductor wafer 5, the motor 7 made to rotate a stage 6, and the process cup 8 which prevents scattering of the waterdrop at the time of washing. The exhaust port 9 is connected to the process cup 8. Moreover, 2 fluid jet nozzle 10 for washing was held, and it has the robot arm 4 to which it is made to move.

[0038] Next, actuation of this washing station is explained. The semi-conductor wafer 5 is fixed to a stage 6, and it rotates at a predetermined rotational frequency by the motor 7. The gas pressurized from gas supply means 2a and the liquid pressurized from liquid supply means 3a are supplied through the gas input 2 and the liquid input 3 in the mixer tube 12 of 2 fluid jet nozzle 10 for washing, as shown in drawing 1 . Gas and a liquid are mixed and a liquid changes to the granular drop 1 between the mixed sections B in 2 fluid jet nozzle 10 for washing, i.e., b-c in drawing of the mixer tube 12. Between a-b in drawing of the acceleration section 11 at the tip of a nozzle in 2 fluid jet nozzle 10 for washing, i.e., an acceleration tube, it is accelerated by the flow of gas, and particle size becomes still smaller and a drop 1 blows off from a nozzle tip.

[0039] As shown in drawing 2 , the spouted drop 1 collides with semi-conductor wafer 5 front face, and removes the contamination which has adhered on semi-conductor wafer 5 front face. The contamination removed from the semi-conductor wafer 5, the drop 1 which dispersed after the surface collision of the semi-conductor wafer 5, and the gas stream which blew off from 2 fluid jet nozzle 10 for washing are discharged out of a process cup 8 from an exhaust port 9. In order to wash the semi-conductor wafer 5 whole surface at the time of washing, 2 fluid jet nozzle 10 for washing is held, and 2 fluid jet nozzle 10 for washing is horizontally moved along the front face of the semi-conductor wafer 5 by the robot arm 4 to which it is made to move.

[0040] Drawing 3 is a graph which shows the relation (flow characteristics) of the supply pressure of the gas of 2 fluid jet nozzle 10 for washing of the gestalt of this operation and the flow rate of gas in comparison with the conventional 2 fluid jet nozzle 70 for washing shown in drawing 18 . In drawing 3 , as the flow rate line 3-1 shows the quantity of gas flow of 2 fluid jet nozzle 10 for washing of the gestalt of this operation shown in drawing 1 and explained it as an example previously, the bores of the acceleration section A are [3mm (the cross section is 2 7mm) and the internal cross section of the mixed section B] the things of 2 20mm. Moreover, as the flow rate line 3-2 shows the quantity of gas flow of the conventional 2 fluid jet nozzle 70 for

washing shown in drawing 18 and being previously explained as an example, for the bore of the 1st duct 72, the outer diameters of 4.35mm (the cross section is 2 15mm) and the 2nd duct 73 are [6.8mm and the internal cross section of the 1st duct 72 of the outside of the 2nd duct 73] the things of 2 6.8mm.

[0041] When the supply pressure of gas is the same, as compared with the conventional 2 fluid jet nozzle 70 for washing, as for 2 fluid jet nozzle 10 for washing of this invention, the flow rate of gas becomes large, so that drawing 3 may show. As explanation of a Prior art described this, in the conventional 2 fluid jet nozzle 70 for washing shown in drawing 18 , the 1st duct 72 is a straight pipe and the internal cross section of the 1st duct 72 through which the gas of the outside of the 2nd duct 73 passes becomes smaller than the cross section between a-b in drawing. Therefore, rate-limiting is carried out by the narrowest internal cross section [of a path] of the 1st duct of the outside of the 2nd duct 73, namely, a rate is restricted, and the flow rate of gas decreases.

[0042] Drawing 4 is a graph which shows the relation of the supply pressure of the gas of 2 fluid jet nozzle 10 for washing of the gestalt of this operation and the spray velocity of a drop in comparison with the conventional 2 fluid jet nozzle 70 for washing. In drawing 4 , a speed line 4-1 shows the spray velocity of the drop of 2 fluid jet nozzle 10 for washing of the gestalt of this operation, and a speed line 4-2 shows the spray velocity of the drop of the conventional 2 fluid jet nozzle 70 for washing. When the supply pressure of gas is the same, as compared with the conventional 2 fluid jet nozzle 70 for washing, as for 2 fluid jet nozzle 10 for washing of this invention, the spray velocity of a drop becomes quick, so that drawing 4 may show.

[0043] The bore of the acceleration tube 11 of the nozzle point of 4.35mm (the cross-sectional area is 2 15mm) and 2 fluid jet nozzle 10 for washing of this invention assumes [the bore of the nozzle point of the conventional 2 fluid jet nozzle 70 for washing] the case of 3mm (the cross-sectional area is 2 7mm) the same [with having explained previously] as a concrete example. As for the spray velocity of the drop in 2 fluid jet nozzle 10 for washing of this invention, the supply pressure of gas can become whenever [sonic] in about 3 kgf/cm2. The supply pressures of gas are about 7 kgf/cm2, and the spray velocity of the drop in the conventional 2 fluid jet nozzle 70 for washing is 224 m/sec. In order to become whenever [sonic] in the conventional 2 fluid jet nozzle 70 for washing, the supply pressure of gas is required two or more 10 kgf/cm. Therefore, as for 2 fluid jet nozzle for washing of this invention, the supply pressure of gas can raise the spray velocity of a drop with low voltage more.

[0044] Drawing 5 is a graph which shows the relation between the die length between a-b in the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing of this invention, i.e., drawing 1 of an acceleration tube 11, and the spray velocity of a drop. In 30mm or less, the spray velocity of a drop has the late die length of the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing so that drawing 5 may show. This is because the drop 1 formed in the mixed section B of 2 fluid jet nozzle 10 for washing cannot fully receive acceleration according [the acceleration section A at the tip of a nozzle] to the flow of gas since it is short. Moreover, as for the spray velocity of a drop, the die length of the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing becomes late gently in 200mm or more. For the acceleration section A at the tip of a nozzle, since it is long, this is for the flow rate of gas to fall according to the fluid resistance force in piping. Therefore, 30-200mm is suitable for the die length of the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing.

[0045] Drawing 6 is a shown graph which showed the relation between the spray velocity of the drop of 2 fluid jet nozzle for washing, and a detergency with the elimination factor of a contamination. A detergency becomes large in proportion to the spray velocity of a drop so that more clearly than drawing 6 .

[0046] Drawing 7 is the graph which showed the relation between the flow rate of a liquid at the time of changing the cross section in tubing of the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing of this invention, and a detergency with the elimination factor of a contamination. In drawing 7 , as for a curve 7-1, 7-2, and 7-3, the internal cross section of the acceleration tube 11 at the tip of a nozzle shows change of the detergency in 2 3mm 2 or

5mm 2 or 7mm, respectively. 2 fluid jet nozzle for washing into which this graph changed only the cross-sectional area in tubing of the acceleration section A at the tip of a nozzle -- setting -- the supply pressure of gas - it is made a law and the flow rate of a liquid is changed. Therefore, when the cross section in tubing of the acceleration tube 11 at the tip of a nozzle is large, the flow rate of gas increases.

[0047] When there are few flow rates of a liquid, a detergency becomes small so that it may see to drawing 7 . Since there is little number of a drop, this is because washing effectiveness fell. About 100 or more mL/min of flow rates of the liquid for obtaining sufficient elimination factor under these conditions is required. Moreover, when there are many flow rates of a liquid, a detergency becomes small gently. Since the amount of the drop which can fully accelerate this to the flow rate of a certain gas is restricted, it is because there were too many flow rates of a liquid and the rate of a drop became slow.

[0048] Moreover, when the cross section in tubing of the acceleration section A at the tip of a nozzle is small, since there are few flow rates of gas, the amount of a fully accelerable drop, i.e., the flow rate of a liquid, decreases, and an elimination factor is low. On the other hand, since ****** and the flow rate of gas have much cross section in tubing of the acceleration section A at the tip of a nozzle, the amount of a fully accelerable drop, i.e., the flow rate of a liquid, increases, and an elimination factor becomes high. However, if the cross section in tubing of a nozzle point is too large, there are many flow rates of gas, and a running cost becomes high and is not a best policy economically. Moreover, the flow rate of gas increases, it is necessary to increase the displacement for fully performing the exhaust air in a process cup 8, a running cost becomes high, and it is not a best policy economically. If these are taken into consideration, it is appropriate for the cross section in tubing of the acceleration tube 11 at the tip of a nozzle to carry out to two or more [3mm]. Moreover, as for the cross section, about [3-15mm] two are practical in practice, and according to the experiment etc., about [7mm] two become the optimal about. Furthermore, in order to make the fluid resistance force small, the configuration of the acceleration section A at the tip of a nozzle is a tube, and is desirable. [of a straight pipe]

[0049] The cross section of the nozzle mixing section B with which the gas and the liquid which were pressurized are respectively mixed through piping must be larger than the cross section in tubing of the acceleration section A at the tip of a nozzle at least. In being smaller than the cross section in tubing of the acceleration section A at the tip of a nozzle, the flow rate of gas is extracted in the mixed section B, and it does not reach the rate of the drop for obtaining sufficient detergency. Moreover, when the cross section of the mixed section B is too large, detailed-ization of the drop in the mixed section is not fully made, but washing effectiveness becomes low. If the die length of the mixed section B is short, acceleration of the drop in the mixed section B is insufficient, and sufficient detergency cannot be obtained. moreover -- if the die length of the mixed section B is long -- the fluid resistance force in the mixed section B -- high -- becoming -- the flow rate of gas -- few -- a fence -- **** -- sufficient detergency cannot be obtained. Therefore, if these are taken into consideration, the cross section of the mixed section B must be larger than 2 at least the minimum value of 3mm of the suitable cross section in tubing of the acceleration section A at the tip of a nozzle, therefore two or more [3mm] are suitable for it. Moreover, 2 is suitable 3-200mm practical. Moreover, the die length of the mixed section B has 3-50 practicalmm. In order to make the fluid resistance force small, the configuration of the mixed section B has a desirable tube further again.

[0050] The cross section of the input 2 of the gas supplied to said mixed section B is larger than the minimum part of the cross section in tubing of the acceleration section A at the tip of a nozzle at least, and must be made into the cross section of the mixing-on structure section B below equivalent so that the flow rate of gas may not be extracted. Therefore, the cross section of the gas input 2 is larger than 2 the minimum value of 3mm of the suitable cross section in tubing of the acceleration section A, and it is necessary to make it or more [at least 3mm] into two. Moreover, about [7-200mm] two are suitable practical. Moreover, the magnitude for passing the flow rate of the minimum liquid for obtaining sufficient elimination factor and about 100 mL/min or more is required for the cross section of the input 3 of a liquid. For that, also theoretically, there should just be the cross section with 2 more than of 0.04mm of the liquid

input 3. Moreover, it is better not to be too large so, in order to raise detailed-izing of the drop in the mixed section B, and the initial velocity of a drop. About [0.04-20mm] two are suitable practical.

[0051] Next, the underlying concept of actuation of 2 fluid jet nozzle for washing by this invention and an operation is explained using drawing 8 . Drawing 8 is drawing for explaining the detergency by the injected drop. First, as shown in drawing 8 (a), suppose that a drop 1 collides at the rate of Vo to the front face of the semi-conductor wafer 5. Then, as shown in drawing 8 (b), the pressure P called impact pressure to the lower part of a drop 1 arises in the case of the collision of a drop 1. Next, as shown in drawing 8 (c), the flow Vf called a horizontal radiation style arises by this impact pressure. Furthermore, a drop 1 deforms, as shown in drawing 8 (d), and the contamination on the semi-conductor wafer 5 is removed by the force received from impact pressure P or this radiation style Vf.

[0052] Impact pressure P is given by the following formula.

[Equation 1]

$$P = \frac{1}{2}\alpha\rho_L C_L V_0 \quad \cdots\cdots\cdots (1)$$

Vo expresses among the formula the reduction multiplier which a collision rate and rhoL show alpha by the consistency of a liquid, and shows CL by the degree type whenever [in a liquid / acoustic-velocity].

[Equation 2]

$$\alpha = \frac{0.41}{1 + 0.59\left(\rho_L C_L / \rho_S C_S\right)} \quad \cdots\cdots (2)$$

rhos expresses the consistency of a semi-conductor wafer substrate among a formula, and Cs expresses whenever [in a semi-conductor wafer substrate / acoustic-velocity].

[0053] The rate Vf of a radiation style is expressed with a degree type.

[Equation 3]

$$V_f = \left(\alpha C_L V_0\right)^{1/2} \quad \cdots\cdots\cdots (3)$$

[0054] If the contamination on the semi-conductor wafer 5 is made into globular form particle, the external force (the removal force or detergency) D which this particle receives is expressed with a degree type.

[Equation 4]

$$D = C_D \frac{\rho_L}{2} V_f^2 \frac{\pi}{4} d^2 \quad \cdots\cdots\cdots (4)$$

[Equation 5]

$$D = C_D P \frac{\pi}{4} d^2 \quad \cdots\cdots\cdots (5)$$

CD expresses a drag coefficient among a formula and d expresses the diameter of particle. In addition, although a form is different, as for [a formula 4] and [a formula 5], the value same as a result is acquired. The detergency D is proportional to the collision rate Vo of a drop, and if the collision rate Vo is gathered, a detergency D will become large so that it may understand from now on.

[0055] Although it does not depend for a detergency D on the particle size of a drop 1, the area (this affects the elimination factor of a contamination) with which a drop 1 collides changes. the amount of supply of a liquid - if particle size of a drop 1 is made small when it considers as a law, the number of a drop 1 will increase in inverse proportion to the cube of particle size, and, on the other hand, the area with which one drop collides will decrease in proportion to the square of particle size. The area with which the whole drop collides increases as a result, and a cleaning effect increases. Moreover, this model is applicable not only to the so-called particle of a drop and a liquid but the ice grain child in ice scrubber washing which is a Prior art. In the case of a ice grain child, whenever [in a ice grain child / acoustic-velocity], since CL is larger than

whenever [in liquids, such as water / acoustic-velocity], when a collision rate is the same, it becomes larger [a ice grain child's detergency] than a drop.
[0056] Although the above-mentioned model assumes the case where a drop 1 collides perpendicularly to the front face of the semi-conductor wafer 5, since a certain include angle is given, [a formula 4] and [a formula 5] are respectively expressed with a degree type in fact.
[Equation 6]

$$D = C_D \frac{\rho_L}{2} V_f^2 \frac{\pi}{4} d^2 \sin(\theta) \quad \cdots\cdots (6)$$

[Equation 7]

$$D = C_D P \frac{\pi}{4} d^2 \sin(\theta) \quad \cdots\cdots (7)$$

theta expresses the collision include angle of the drop 1 with the direction of semi-conductor wafer 5 front face among the formula.
[0057] Drawing 9 is the graph which showed the relation between the collision include angle of a drop, and a detergency with the elimination factor of a contamination. If the collision include angle of a drop is ******(ed) as shown in drawing 9 , according to a sign curve, a detergency will become large.
[0058] Drawing 10 is a graph which shows the relation of the particle size and the elimination factor of the particle in the various washing approaches. Washing by 2 fluid jet nozzle 70 for washing of the former [Rhine / 10-2 / washing according / Rhine 10-1 in drawing / to 2 fluid jet nozzle 10 for washing of this invention and / in drawing] and Rhine 10-3 in drawing are curves which show the elimination factor by the conventional high-pressure jet backwashing by water. In addition, although ice scrubber washing which is a Prior art is not indicated, it is comparable as Rhine 10-1. In high-pressure jet backwashing by water of Rhine 10-3 in drawing, particle 1 micrometer or less is unremovable as shown in drawing 10 . Moreover, in washing by the conventional 2 fluid jet nozzle 70 for washing of Rhine 10-2 in drawing, although a detergency is higher than high-pressure jet backwashing by water, 0.1-micrometer particle is unremovable. On the other hand, washing by 2 fluid jet nozzle 10 for washing of this invention of Rhine 10-1 in drawing has a detergency higher than these, and removal of particle 0.1 micrometers or less is possible for it.
[0059] In addition, with the gestalt of the above-mentioned implementation, although the semi-conductor wafer was illustrated as a substrate, this invention is not restricted to this, and also when removing the contamination which has adhered on the front face of substrates, such as liquid crystal and a photo mask, it can be applied.
[0060] Gestalt 2. drawing 11 of operation is the sectional view of 2 fluid jet nozzle 20 for washing concerning the gestalt of other operations of this invention. This 2 fluid jet nozzle 20 for washing consists of the mixed sections B containing the mixer tube 22 which mixes the acceleration section A which consists of an acceleration tube 21 which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of the pressurized gas and the side attachment wall of the mixer tube 22 are penetrated, the input 3 of a liquid carries out opening into the mixer tube 22, and the inhalant canal 23 of the liquid with which a part for the point has been arranged the mixer tube 22 and in the shape of the same axle is formed in the mixer tube 22.
[0061] The description of this 2 fluid jet nozzle 20 for washing is as follows. Between c-d in drawing of the mixed sections B (between b-d in drawing) with which the gas and the liquid which were pressurized are mixed It has the structure of double tubing where gas flows to an outer tube (the 1st duct 22), and a liquid flows to an inner tube (the 2nd duct 23), like the Prior art. As a difference The internal cross section of the 1st duct 22 of the outside of the 2nd duct 23 through which the gas of this part passes is a larger point than the cross section of the acceleration tube 11 (between a-b in drawing) at the tip of a nozzle. Therefore, since rate-limiting [of the double tubing in the mixed section B] is not carried out by the way, namely, a rate is not restricted and a large flow rate is obtained with a supply pressure lower than the conventional 2 fluid jet nozzle 70 for washing, the spray velocity of gas of a drop is quick and its

detergency is high.
[0062] Moreover, another description of this 2 fluid jet nozzle 20 for washing is the point from the outlet of the 2nd duct 23 in the mixed section B, it is until it connects with an acceleration tube 21 (between b-c in drawing), and it is the point that the 1st duct 22 is becoming thin gradually to the cross section of an acceleration tube 21. Thereby, the rate of the gas between b-c in drawing becomes quick gradually, without receiving loss of the fluid resistance force. From the outlet 3 of the 2nd duct 23, it is gradually accelerated by the flow of this gas, and the breathed-out drop 1 is made detailed more. Therefore, the particle size of a drop 1 is small, and the spray velocity of a drop 1 becomes quick and a detergency is higher than 2 fluid jet nozzle 10 for washing of the gestalt of operation shown in drawing 1 .
[0063] As a concrete example of this 2 fluid jet nozzle 20 for washing The die length of the acceleration section A at the tip of a nozzle (between a-b in drawing) is [the cross section in 100mm and tubing] 2 7mm. For the cross section of the part into which the gas of the outside of the 2nd duct 23 between 20mm and c-d in drawing flows [the die length between b-c in drawing of the mixed section B (between b-d in drawing) / the die length between 20mm and c-d in drawing], the cross section of the input 2 of 2 and gas is [the cross section of the input 3 of 2 and a liquid] 2 3mm 20mm 20mm. Furthermore, the 1st duct 22 and 2nd duct 23 are [both] a tube configuration, and are arranged in the c section in drawing of the mixed section B concentric circular. Thus, by constituting, a drop is made detailed more and the spray velocity of a drop can realize high 2 fluid jet nozzle for washing of a detergency quickly therefore.
[0064] Gestalt 3. drawing 12 of operation is the sectional view of 2 fluid jet nozzle 30 for washing concerning the gestalt of other operations of this invention. This 2 fluid jet nozzle 30 for washing consists of the mixed sections B (b-d in drawing) containing the mixer tube 32 which mixes the acceleration section A (a-b in drawing) which consists of an acceleration tube 31 which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of the pressurized gas and the side attachment wall of the mixer tube 32 are penetrated, the input 3 of a liquid carries out opening into the mixer tube 32, and the inhalant canal 33 of the liquid with which a part for the point has been arranged the mixer tube 32 and in the shape of the same axle is formed in the mixer tube 32. Furthermore, the inhalant canal 34 of gas is arranged in the shape of the same axle in the inhalant canal 33 of this liquid, and it has 3 detonator structures. The acceleration section A at between b-c in drawing of the mixed section B after the gas and the liquid which were pressurized were mixed, and the tip of a nozzle (between a-b in drawing) is the same as the gestalt of operation of drawing 11 .
[0065] The description of this 2 fluid jet nozzle 30 for washing is as follows. Namely, this 2 fluid jet nozzle 30 for washing The 1st duct 32 where gas passes through the inside of it between c-d in drawing of the mixed section B, The 2nd duct 33 where the side attachment wall of the 1st duct 32 is penetrated, the point is prolonged even in the 1st duct 32, and a liquid passes through the inside of it from the outside of the 1st duct 32, Furthermore, from the outside of the 2nd duct 33, the side attachment wall of the 2nd duct 33 was penetrated, the point was prolonged even in the 2nd duct 33, and it has the 3rd duct 34 where gas passes through the inside of it. Moreover, the point of the 3rd duct 34 and the point of the 2nd duct 33 are prolonged in the same direction as the direction where the 1st duct 32 extends.
[0066] The internal cross section of the 1st duct 32 of the outside of the 2nd duct 33 through which the part of this 3 detonator structure and the gas between c-d in drawing pass is larger than the cross section of the acceleration section A at the tip of a nozzle (between a-b in drawing) like the gestalt of operation shown in drawing 11 . In the point of the 3rd duct 34, the gas which came out from the 3rd duct 34, and the liquid which flows the inside of the 2nd duct 33 are mixed, a drop is formed, and detailed-ization of a drop is further promoted by the flow of gas in the 1st duct 32.
[0067] The drop more detailed than the drop by 2 fluid jet nozzle for washing of the gestalt of operation shown by drawing 1 or drawing 11 as a result is obtained, and the spray velocity of a drop becomes quick. As a concrete example, the particle size of the drop in the conventional 2 fluid jet nozzle 70 for washing About 20 micrometers, The particle size of the drop in 2 fluid jet nozzle 10 for washing of the gestalt of operation shown by drawing 1 About 10 micrometers, The

particle size of the drop in 2 fluid jet nozzle 30 for washing of the gestalt of this operation which the particle size of the drop in 2 fluid jet nozzle 20 for washing of the gestalt of operation shown by drawing 11 showed by about 5 micrometers and drawing 12 is about 2 micrometers. Therefore, the detergency in 2 fluid jet nozzle 30 for washing of the gestalt of this operation of the conventional 2 fluid jet nozzle 70 for washing is higher than 2 fluid jet nozzle for washing of the gestalt of operation shown by drawing 1 or drawing 11 from the first.

[0068] Gestalt 4. drawing 13 of operation is the sectional view concerning the gestalt of other operations of this invention showing the structure of 2 fluid jet nozzle 40 for washing. This 2 fluid jet nozzle 40 for washing consists of the mixed sections B (b-d in drawing) containing the mixer tube 42 which mixes the acceleration section A (a-b in drawing) which consists of an acceleration tube 41 of the Laval-nozzle configuration which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of gas and the input 3 of a liquid which were pressurized are established in the mixer tube 42. The configuration between b-c in drawing of the duct 42 of the mixed section B where the gas and the liquid which were pressurized are mixed is the same as the 1st duct 22 of the gestalt of operation shown by drawing 11 , and the configuration between c-d in drawing of the duct 42 of the mixed section B is the same as the configuration between b-c in drawing of the mixed section B of the gestalt of operation shown by drawing 1 .

[0069] The description of 2 fluid jet nozzle 40 for this washing is the point that the bore of the acceleration section A at the tip of a nozzle (between a-b in drawing) is the Laval-nozzle configuration which becomes large gradually toward the exhaust nozzle of a drop. 30-200mm is suitable for the die length of the acceleration section A at the tip of a nozzle of this 2 fluid jet nozzle 40 (between a-b in drawing) at the same reason as the case of the straight pipe of the gestalt 1 of operation. Moreover, the cross section is the minimum converging section (throat section), i.e., the b section in drawing, and is [two or more / 3mm] required for the cross section in tubing of the acceleration section A at the same reason as the case of the straight pipe of the gestalt 1 of operation. Moreover, about [3-10mm] two are suitable practical. Furthermore, at least, the cross section of the outlet section, i.e., the a section in drawing, is larger than a converging section, and required. [two or more / 3mm] About [6-20mm] two are suitable practical.

[0070] Although it is for a Laval nozzle (Laval nozzle) accelerating gas at a supersonic speed in a duct at - **, 2 fluid jet nozzle 40 for this washing is optimizing the configuration in order to make a drop accelerate to a supersonic speed. When [which needs about 100 or more mL/min of flow rates of the liquid for obtaining sufficient elimination factor] there are many flow rates of a liquid, a running cost becomes high, and as seen to drawing 7 , since it is not a best policy economically, the flow rate of the optimal liquid is 100 - 300 mL/min. The minimum quantity of gas flow for accelerating the drop of this flow rate to a supersonic speed is 200 - 600 L/min.

[0071] In order to obtain this quantity of gas flow in the range to a maximum of 7 kgf/cm2 which is the supply pressure of the gas usually used, the cross section of the converging section (throat section) of the acceleration tube 41 of 2 fluid jet nozzle 40 and the b section in drawing must be carried out more than 2 or it 3-10mm. Moreover, since a drop is accelerable to a supersonic speed if the cross section of the outlet section of the acceleration tube 41 of 2 fluid jet nozzle 40 and the a section in drawing is made into twice the cross section of a converging section (throat section), the optimum value of the cross section of the outlet section is set to 2 6-20mm. In 2 fluid jet nozzle 40 of this condition, the spray velocity of a drop 1 reaches about 500 about 1.5 times as much m/sec as whenever [sonic]. Since this 2 fluid jet nozzle 40 can spout a drop 1 at a supersonic speed as mentioned above, its detergency is higher than ice scrubber washing, the conventional 2 fluid jet nozzle 70, and 2 fluid jet nozzle of the gestalt of operation further shown by drawing 1 , drawing 11 , or drawing 12 .

[0072] Gestalt 5. drawing 14 of operation is the sectional view showing the structure of 2 fluid jet nozzle 50 for washing of this invention which starts the gestalt of other operations further. This 2 fluid jet nozzle 50 for washing consists of the mixed sections B (b-d in drawing) containing the mixer tube 52 which mixes the acceleration section A (a-b in drawing) which consists of an acceleration tube 51 which aims at acceleration of a drop in the part at the tip of

a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of gas and the input 3 of a liquid which were pressurized are established in the mixer tube 52. The configuration of the mixed section B (between b-c in drawing) where the acceleration section A (between a-b in drawing), the pressurized gas, and the liquid at the tip of a nozzle are mixed is the same as the gestalt of operation shown in drawing 1 .

[0073] The description of 2 fluid jet nozzle 50 for this washing is a point equipped with the straightening vane 55 which controls the direction of the jet of the drop which blew off, and gas between a-b in the outlet of the acceleration section A at the tip of a nozzle, the a section in drawing, or drawing. This straightening vane 55 spreads [at the jet direction and a right angle / in 10-100mm] from the acceleration tube 51 of 2 fluid jet nozzle 50 for washing and is monotonous.

[0074] Drawing 15 is the mimetic diagram in which having equipped with the aforementioned 2 fluid jet nozzle 50 for washing, for example, showing the configuration of the washing station for semi-conductor wafers. This washing station equips 2 fluid jet nozzle 50 for washing with gas supply means 2a which carries out pressurization supply of gas and the liquid, and liquid supply means 3a. Moreover, this equipment is equipped with the stage 6 holding the semi-conductor wafer 5, the motor 7 made to rotate a stage 6, and the process cup 8 which prevents scattering of the waterdrop at the time of washing. The exhaust port 9 is connected to the process cup 8. Moreover, 2 fluid jet nozzle 10 for washing was held, and it has the robot arm 4 to which it is made to move. Said straightening vane 55 is arranged in the location distant from semi-conductor wafer 5 front face 5-50mm, and it is arranged so that it may spread in parallel mostly with the front face of a semi-conductor wafer.

[0075] As an example, as shown in drawing 14 and drawing 15 , a straightening vane 55 is the disk with a radius of 50mm attached at the tip of a nozzle outlet. In order to be arranged at right angles to the location where 2 fluid jet nozzle 50 for washing separated from semi-conductor wafer 5 front face 20mm at the time of washing and to wash the whole front face of the semi-conductor wafer 5, horizontal migration is carried out along a front face. That is, the straightening vane 55 is arranged in parallel with the front face of the semi-conductor wafer 5, and the location distant 20mm.

[0076] Although the flow (jet) of the drop 1 which blew off from 2 fluid jet nozzle 50 for washing, and gas once tends to collide with the front face of the semi-conductor wafer 5 and tends to disperse upwards, a straightening vane 55 distributes it along the front face of ********** and the semi-conductor wafer 5. Although the jet immediately after blowing off from 2 fluid jet nozzle 50 for washing is high-speed, the jet around a straightening vane 55 becomes a low speed according to the rectification effectiveness of a straightening vane 55. Although the die length of the acceleration section A at the tip of a nozzle (between a-b in drawing) is [the cross section in 100mm and tubing] 2 7mm, and the rates of the jet immediately after blowing off are 330 m/sec of whenever [sonic] as a concrete example when the flow rate of 150 L/min and a liquid is made into 100 mL/min for the flow rate of gas, the rate of the jet around a straightening vane 55 serves as 0.4 m/sec.

[0077] When there is no straightening vane, it reflects from the front face of the semi-conductor wafer 5, and the flow (jet) of the drop which blew off from 2 fluid jet nozzle for washing, and gas disperses upwards. After the contamination adhering to the front face of the semi-conductor wafer 5 disperses upwards with a drop, it adheres to the front face of the semi-conductor wafer 5, and makes the semi-conductor wafer 5 pollute, although - ** is removed from the front face of the semi-conductor wafer 5 by the collision of a drop. Therefore, when there is no straightening vane 55, in order to eliminate promptly the flow (jet) of the drop which blew off from 2 fluid jet nozzle 50 for washing, and gas, and the removed contamination from the front face of the semi-conductor wafer 5, the jet include angle of 2 fluid jet nozzle for washing is made into 60 degrees or less, and the large flow rate is exhausted in this and the location which countered.

[0078] Since the above-mentioned problem is solved by having a straightening vane 55, it is possible to make the jet include angle of 2 fluid jet nozzle for washing into 90 degrees (perpendicular direction), and a detergency becomes high. Moreover, since the rate of a jet is

made late near the straightening vane 55, it is possible to lessen displacement. In the case of the conventional 2 fluid jet nozzle 70 for washing explained by drawing 18 , displacement is specifically required more than about 5m3/min, but in the case of 2 fluid jet nozzle 50 for washing of this invention, below 2m3/min are enough.
[0079] If it approaches not much from the front face of the semi-conductor wafer 5, since ****** will become small about scattering of a jet even in ** if the location of a straightening vane 55 separates from the front face of the semi-conductor wafer 5 not much, and the fluid resistance force of the gas which flows between a straightening vane 55 and the front faces of the semi-conductor wafer 5 will become large, the spray velocity of a drop becomes slow. For this reason, the place distant from the front face of the semi-conductor wafer 5 5-50mm of the location of a straightening vane 55 is the optimal.
[0080] Moreover, if the diameter of the configuration of a straightening vane 55 is small in the case of a disk like the gestalt of this operation, even in **, ****** will become small about scattering of a jet, and if the diameter is not much large, anchoring on a realistic equipment configuration and migration with the robot arm 4 will become difficult. For this reason, when the configuration of a straightening vane 55 is a disk, 10-100mm is suitable for that radius practical.
[0081] Gestalt 6. drawing 16 of operation is the sectional view showing the structure of 2 fluid jet nozzle 60 for washing of this invention which starts the gestalt of other operations further. The gestalt of this operation shows the nozzle which has the straightening vane which deformed. This 2 fluid jet nozzle 60 for washing consists of the acceleration section A (a-b in drawing) which consists of an acceleration tube 61, the mixed section B containing the mixer tube 62 (b-d in drawing), and a straightening vane 65 formed at the tip of an acceleration tube 61. The input 2 of gas and the input 3 of a liquid which were pressurized are established in the mixer tube 52. The configuration of the mixed section B (between b-c in drawing) where the acceleration section A (between a-b in drawing), the pressurized gas, and the liquid at the tip of a nozzle are mixed is the same as the gestalt of operation shown in drawing 14 . They are the straightening vane 65 when drawing 16 (b) looks at the sectional view of the straightening vane 65 of a direction perpendicular to the space of drawing 16 (a) to the injection direction and hard flow of a drop and drawing 16 (c) looks at a nozzle 60, and drawing of the end face of an acceleration tube 61.
[0082] It has the configuration of the core box in which only one side face carried out opening while carrying out opening of the straightening vane 65 with which this 2 fluid jet nozzle 60 for washing is equipped in the injection direction of a drop. Opening of while was carried out, and as a side face is turned to in the direction of an exhaust port, it is used for it. In this case, the rate of the jet which blew off from 2 fluid jet nozzle 60 for washing becomes slow near a straightening vane 65 according to the rectification effectiveness of a straightening vane 65, and most jets flow toward an exhaust port 9 from the side face of the method of one to which opening of the straightening vane 65 was carried out. For this reason, it is possible for exhaust air effectiveness to improve further and to lessen displacement. As mentioned above, since exhaust air effectiveness improves by forming the straightening vane which stops the jet of the gas reflected from washed material, such as a semi-conductor substrate, and a drop in the tip of a nozzle, or its near, the displacement of a washing station can raise cleaning effect sufficient at least.
[0083]
[Effect of the Invention] Since the cross section of the minimum part of the gas circulation way of the mixed section which mixes the gas and the liquid which were pressurized in 2 fluid jet nozzle for washing of this invention, and forms a drop was made larger than the minimum part of the cross section of the passage of the acceleration section which injects a drop in mind as explained above, low gas pressure also raises the jet velocity of a drop, and ** which performs powerful washing is made. Moreover, since the acceleration section was made into the circular straight pipe or the configuration was optimized, high-speed drop injection can be performed further.
[0084] Moreover, in 2 fluid jet nozzle for washing of this invention, since that bore made the acceleration section the Laval-nozzle configuration which becomes large gradually toward the jet

direction of a drop from the connection side with the mixed section and that configuration was optimized, injection of the drop exceeding acoustic velocity is realizable.
[0085] Moreover, in 2 fluid jet nozzle for washing of this invention, since the configuration of the mixed section of pressurization gas and a liquid was made cylindrical and that configuration was optimized, a drop can be formed the optimal and a cleaning effect can be heightened.
[0086] Moreover, in 2 fluid jet nozzle for washing of this invention, since it formed so that the cross section might be gradually reduced in the direction which connects the mixed section with the acceleration section, and that configuration was optimized, drop injection of a scale and a high speed can be performed for detailed-ization of a drop.
[0087] Moreover, in 2 fluid jet nozzle for washing of this invention, since the cross section of the gas input supplied to the mixed section and the cross section of the input of a liquid were optimized, it can be made detailed effectively [a drop] and a cleaning effect can be heightened.
[0088] Moreover, since it was made the double structure equipped with pressurization gas, the outer tube to which gas passes the mixed section of a liquid, and the inner tube which spouts a liquid in the passage direction of gas in this outer tube, a detailed drop can be formed effectively and a cleaning effect can be raised in 2 fluid jet nozzle for washing of this invention.
[0089] Moreover, since it was made 3-fold structure equipped with pressurization gas, the outer tube to which gas passes the mixed section of a liquid, the inner tube which is arranged into this outer tube and spouts a liquid, and the 3rd tubing which is further arranged into this inner tube and spouts gas in 2 fluid jet nozzle for washing of this invention, it can perform being able to form a drop effectively and attaining that detailed-ization.
[0090] Moreover, in 2 fluid jet nozzle for washing of this invention, since it had the straightening vane in the jet direction of a drop, and the direction which carries out an abbreviation rectangular cross and that configuration was optimized near the point of an acceleration tube, the contamination which has adhered on front faces, such as a substrate, can be removed, without doing damage to front faces, such as a semi-conductor substrate.
[0091] Moreover, in the washing station of this invention, adhesion foreign matters, such as a semi-conductor substrate, are powerfully removable taking advantage of actuation of the above 2 fluid jet nozzles for washing. Moreover, by using 2 fluid jet nozzle for washing equipped with the straightening vane, scattering of a drop can be prevented and displacement can be lessened.
[0092] Moreover, in 2 fluid jet nozzle for washing and the washing station of this invention, since the supply pressure of the gas supplied to 2 fluid jet nozzle and a liquid is chosen appropriately, the effectiveness of the washing station using 2 fluid jet nozzle for washing and this which were mentioned above can be demonstrated appropriately, and powerful washing can be performed.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention] This invention relates to 2 fluid jet nozzle for washing which removes the contamination which has adhered on a semi-conductor substrate etc. in more detail about 2 fluid jet nozzle for washing. This invention relates to the washing station from which the contamination which has adhered on a substrate again using this 2 fluid jet nozzle for washing is removed.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] Generally in the manufacture process of a semi-conductor, various contaminations adhere on the front face of a semi-conductor wafer. For example, if an insulator layer and a metal membrane are formed by the CVD method or the spatter on a semi-conductor wafer, a particle-like contamination will adhere to the front face. Moreover, after the pattern formation by dry etching, an etching residue (resist residue) metallurgy group contamination adheres. Washing of the drop injection using 2 fluid jet nozzle for high-pressure jet backwashing by water, ice scrubber washing, and washing as an approach of removing these contaminations is proposed from the former.
[0003] Drawing 17 is the mimetic diagram of the conventional washing station by the approach called high-pressure jet backwashing by water. In this washing station, the semi-conductor wafer 5 is held to on a stage 6, and this is rotated by the motor 7. The high-pressure jet nozzle 69 connected through piping from the pure-water pressurizer 68 is arranged to this semi-conductor wafer 5. In this washing approach, first, with the pure-water pressurizer 68, the high pressure of 50 - 100 kgf/cm2 (kg pile / cm2) is pressurized, and liquids, such as pure water, are supplied to the high-pressure jet nozzle 69 through piping. There is a hole of diameter 0.1mm extent in the high-pressure jet nozzle 69, and a liquid blows off from here to the semi-conductor wafer 5 continuously. The contamination with which the liquid which blew off has adhered to the front face of the semi-conductor wafer 5 by colliding with the front face of the semi-conductor wafer 5 is removed, and washing is performed.
[0004] The trouble of this washing approach has a low detergency, and is that particle 1 micrometer or less is fully unremovable. Although what is necessary is to pressurize a liquid more at high pressure and just to make high the spray velocity of the liquid from the high-pressure jet nozzle 69, in order to heighten a detergency, the pure-water pressurizer 68 becomes large-sized equipment, and is not a best policy economically. As an example, when the supply pressures of a liquid are 100 kgf/cm2, the spray velocity of a liquid serves as about 130 m/sec.
[0005] Drawing 18 is the sectional view of the conventional 2 fluid jet nozzle 70 for washing. 2 fluid jet nozzle 70 for washing is equipped with the 1st duct 72 where gas passes through the inside of it, and the 2nd duct 73 where the side attachment wall of the 1st duct 72 is penetrated, the point is prolonged even in the 1st duct 72 from the outside of the 1st duct 72, and a liquid passes through the inside of it. The point of the 2nd duct 73 is prolonged in the same direction as the direction where the 1st duct 72 extends.
[0006] This 2 fluid jet nozzle 70 for washing was used, for example, the mimetic diagram of the configuration of the washing station for semi-conductor wafers is shown in drawing 19 . This washing station is equipped with a process cup 8, the stage 6 holding the semi-conductor wafer 5 in a process cup 8, the motor 7 made to rotate this stage 6, 2 fluid jet nozzle 70 for washing which turns a drop to the front face of the semi-conductor wafer 5, and is spouted, the gas-supply means 2a which supply the gas which pressurized 2 fluid jet nozzle 70 for washing, and the liquid supply means 3a which supply the liquid which pressurized 2 fluid jet nozzle 70 for washing. The exhaust port 9 is connected to the process cup 8. Moreover, 2 fluid jet nozzle 70 for washing was held, and it has the robot arm 4 to which it is made to move.

[0007] Next, actuation of this washing station is explained. The semi-conductor wafer 5 is fixed to a stage 6, and it rotates at a predetermined rotational frequency. The liquid which pressurized the gas pressurized from gas supply means 2a from liquid supply means 3a again is supplied to 2 fluid jet nozzle 70 for washing, respectively. In 2 fluid jet nozzle 70 for washing, as shown in drawing 18 , gas and a liquid are mixed, a liquid changes to the granular drop 1, and between a-b in drawing in the 1st duct 72, it is accelerated by the flow of gas and it blows off from the tip of the 1st duct 72. As shown in drawing 19 , the spouted drop 1 collides with the front face of the semi-conductor wafer 5, and removes the contamination which has adhered on the front face of the semi-conductor wafer 5. The contamination removed from the semi-conductor wafer 5, the drop 1 which dispersed after the surface collision of the semi-conductor wafer 5, and the gas which blew off from 2 fluid jet nozzle 70 for washing are discharged out of a process cup 8 from an exhaust port 9. In order to wash the whole surface of the semi-conductor wafer 5 at the time of washing, 2 fluid jet nozzle 70 for washing is held, and 2 fluid jet nozzle 70 for washing is horizontally moved along the front face of the semi-conductor wafer 5 by the robot arm 4 to which it is made to move.

[0008] This washing station has a high detergency compared with above-mentioned high-pressure jet backwashing by water. Moreover, a running cost is cheaper than the conventional ice scrubber washing. Moreover, since this washing station can control a detergency broadly, it does not have destruction of a detailed pattern and does not do damage to a metal membrane with a small degree of hardness. However, there is a trouble that a cleaning effect is low compared with ice scrubber washing. This reason is explained below.

[0009] In washing by 2 fluid jet nozzle for washing, the detergency is equivalent to the rate of a drop. The rate of a drop is determined by the flow rate of gas, the flow rate of a liquid, the distance between a-b in drawing in the 1st duct 72 of 2 fluid jet nozzle 70 for washing, and the cross section inside the 1st duct 72 in the meantime. For example, if the bore of 100mm and the 1st duct 72 is set [the flow rate of gas / the flow rate of 200 L/min and a liquid] to 4.35mm for the distance between 100 mL/min and a-b, the rate of a drop will serve as 224 m/sec. Usually, since the configuration of 2 fluid jet nozzle for washing is being fixed, although the rate of a drop is determined by the flow rate of gas, and the flow rate of a liquid, it is governed by the flow rate of gas especially with the large volume.

[0010] The 1st duct 72 is a straight pipe and the internal cross section of the 1st duct 72 of the outside of the 2nd duct 73 through which gas passes becomes smaller than the internal cross section between a-b in drawing as shown in drawing 18 . Therefore, rate-limiting [of the flow rate of gas] is carried out by the internal cross section of the 1st narrowest duct 72 of a path of the outside of the 2nd duct 73. That is, the rate is restricted. Usually, the supply pressure of gas is up to a maximum of 10 kgf/cm2, and even about two a maximum of 7 kgf/cm is especially used by the semi-conductor plant. For example, if the outer diameter of the 2nd duct 73 is set to 3.2mm, the internal cross section of the 1st duct 72 of the outside of the 2nd duct 73 where gas flows will be set to 2 6.8mm. If the supply pressure of gas is made into 7 kgf/cm2, the flow rate of gas will serve as about 200 L/min. The rate of the drop in this case serves as 224 m/sec as mentioned above.

[0011] If the part at the tip of 2 fluid jet nozzle 70 for washing makes [many] the flow rate of gas, it is fundamentally possible for the rate of the gas which flows the inside of this in the case of a straight pipe configuration like [between a-b in drawing] up to about 330 m/sec of whenever [sonic]. However, in 2 fluid jet nozzle 70 for washing of the configuration of drawing 18 , the rate of a drop does not reach to whenever [sonic] in the range to a maximum of 7 kgf/cm2 which is the supply pressure of the gas usually used. Since it depends for the detergency on the rate of a drop, the detergency of this 2 fluid jet nozzle 70 for washing is low in the supply pressure range of the gas usually used.

[0012] Although the rate of the increase of the flow rate of gas and a drop will increase if the supply pressure of gas is usually made higher than the use range, maximum is whenever [sonic] as mentioned above. Although stated later, when the collision rate of a ice grain child and a drop is the same, the ice scrubber washing of a detergency is higher at the ice grain child in ice scrubber washing, and the drop in this washing by the difference in the physical-properties value

of ice and liquid (for example, water). In ice scrubber washing, since a ice grain child's rate can be reached to whenever [maximum acoustic-velocity], the detergency of this 2 fluid jet nozzle 70 for washing cannot exceed ice scrubber washing.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Since the cross section of the minimum part of the gas circulation way of the mixed section which mixes the gas and the liquid which were pressurized in 2 fluid jet nozzle for washing of this invention, and forms a drop was made larger than the minimum part of the cross section of the passage of the acceleration section which injects a drop in mind as explained above, low gas pressure also raises the jet velocity of a drop, and ** which performs powerful washing is made. Moreover, since the acceleration section was made into the circular straight pipe or the configuration was optimized, high-speed drop injection can be performed further.
[0084] Moreover, in 2 fluid jet nozzle for washing of this invention, since that bore made the acceleration section the Laval-nozzle configuration which becomes large gradually toward the jet direction of a drop from the connection side with the mixed section and that configuration was optimized, injection of the drop exceeding acoustic velocity is realizable.
[0085] Moreover, in 2 fluid jet nozzle for washing of this invention, since the configuration of the mixed section of pressurization gas and a liquid was made cylindrical and that configuration was optimized, a drop can be formed the optimal and a cleaning effect can be heightened.
[0086] Moreover, in 2 fluid jet nozzle for washing of this invention, since it formed so that the cross section might be gradually reduced in the direction which connects the mixed section with the acceleration section, and that configuration was optimized, drop injection of a scale and a high speed can be performed for detailed-ization of a drop.
[0087] Moreover, in 2 fluid jet nozzle for washing of this invention, since the cross section of the gas input supplied to the mixed section and the cross section of the input of a liquid were optimized, it can be made detailed effectively [a drop] and a cleaning effect can be heightened.
[0088] Moreover, since it was made the double structure equipped with pressurization gas, the outer tube to which gas passes the mixed section of a liquid, and the inner tube which spouts a liquid in the passage direction of gas in this outer tube, a detailed drop can be formed effectively and a cleaning effect can be raised in 2 fluid jet nozzle for washing of this invention.
[0089] Moreover, since it was made 3-fold structure equipped with pressurization gas, the outer tube to which gas passes the mixed section of a liquid, the inner tube which is arranged into this outer tube and spouts a liquid, and the 3rd tubing which is further arranged into this inner tube and spouts gas in 2 fluid jet nozzle for washing of this invention, it can perform being able to form a drop effectively and attaining that detailed-ization.
[0090] Moreover, in 2 fluid jet nozzle for washing of this invention, since it had the straightening vane in the jet direction of a drop, and the direction which carries out an abbreviation rectangular cross and that configuration was optimized near the point of an acceleration tube, the contamination which has adhered on front faces, such as a substrate, can be removed, without doing damage to front faces, such as a semi-conductor substrate.
[0091] Moreover, in the washing station of this invention, adhesion foreign matters, such as a semi-conductor substrate, are powerfully removable taking advantage of actuation of the above 2 fluid jet nozzles for washing. Moreover, by using 2 fluid jet nozzle for washing equipped with the straightening vane, scattering of a drop can be prevented and displacement can be lessened.
[0092] Moreover, in 2 fluid jet nozzle for washing and the washing station of this invention, since

the supply pressure of the gas supplied to 2 fluid jet nozzle and a liquid is chosen appropriately, the effectiveness of the washing station using 2 fluid jet nozzle for washing and this which were mentioned above can be demonstrated appropriately, and powerful washing can be performed.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]
[0013] Moreover, that it is not economical since the trouble of this washing station needs to enlarge displacement of a process cup 8, and in order to fully perform exhaust air, the include angle with semi-conductor wafer 5 front face of 2 fluid jet nozzle 70 for washing is made into 60 degrees or less, and, for this reason, a detergency is that the damage control to a detailed pattern fully becomes difficult. In order that the contamination carried out - ****** from the semi-conductor wafer 5 may not carry out the reattachment to the front face of the semi-conductor wafer 5, the contamination, the drop 1, and gas which were removed must be made to discharge out of a process cup 8 from an exhaust port 9. For this reason, an exhaust port 9 is arranged in the exhaust nozzle of 2 fluid jet nozzle 70 for washing, and the location which countered, and sufficient displacement is required for it. Specifically, in the case of the washing station of drawing 19 , displacement is required more than about 5m3/min.
[0014] Moreover, when an include angle with the semi-conductor wafer 5 of 2 fluid jet nozzle 70 for washing is 60 degrees or more, it reflects on the front face of the semi-conductor wafer 5, and the jet of a drop and gas disperses upwards from up opening of a process cup 8, and makes the front face of the semi-conductor wafer 5 carry out the reattachment of the contamination. It is so high that the collision include angle of a detergency of a drop is perpendicularly near, and extent of the damage to a detailed pattern becomes so small that the collision include angle of a drop is perpendicularly near. The force (external force) which a detailed pattern receives changes, and extent of the damage to a detailed pattern changes with the collision include angles of a drop. Therefore, if a drop is spouted from across to the semi-conductor wafer 5, the difference in the collision include angle of a drop will come out on the front face of the semi-conductor wafer 5, and it will become difficult to control the damage to a detailed pattern.
[0015] Moreover, the trouble in such washing was produced when the contamination which has adhered on substrates, such as not only a semi-conductor wafer but a liquid crystal substrate, a photo mask, etc., was removed.
[0016] As mentioned above, in the conventional washing station, there was a problem that an affix with the low especially detailed detergency to a semiconductor material etc. was fully unremovable. Moreover, there was a problem that the damage to a semiconductor material etc. was fully uncontrollable.
[0017] So, the purpose of this invention is to offer 2 fluid jet nozzle for washing which removes powerfully the contamination which has adhered on front faces, such as a semi-conductor substrate, and the washing station using this. Other purposes of this invention are to offer 2 fluid jet nozzle for washing improved so that the minute foreign matter 1 micrometer or less which has adhered on a substrate etc. could be removed, and a washing station.
[0018] The purpose of further others of this invention is to offer 2 fluid jet nozzle for washing improved so that the spray velocity of a drop could exceed whenever [sonic], and a washing station. The purpose of further others of this invention is to offer the cheap washing station of a running cost.
[0019] The purpose of further others of this invention is to offer 2 fluid jet nozzle for washing improved so that the contamination which has adhered on front faces, such as a substrate, could

be removed without doing damage to front faces, such as a substrate, and a washing station.

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MEANS

[Means for Solving the Problem] 2 fluid jet nozzle for washing of this invention is equipped with the mixed section which mixes the gas and the liquid which were pressurized and forms a drop, and the acceleration tube section which injects said drop in mind, and is characterized by forming more greatly than the cross section of the minimum part of the circulation way of said acceleration tube section the cross section of the minimum part of the circulation way of said gas of said mixed section.
[0021] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by a form being a circular straight pipe among said acceleration tube sections.
[0022] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by the cross section in 30-200mm and tubing making [that die length] said acceleration tube section 3mm straight pipe configuration it is [configuration] two or more.
[0023] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by that bore making said acceleration tube section the Laval-nozzle configuration which becomes large gradually toward the jet direction of a connection side with said mixed section to said drop.
[0024] Moreover, as for 2 fluid jet nozzle for washing of this invention, the cross section in 30-200mm and tubing is characterized by die length making said acceleration tube section two or more [3mm] with a converging section.
[0025] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by making the configuration of said mixed section cylindrical. Moreover, 2 fluid jet nozzle for washing of this invention is characterized by forming so that the cross section may be gradually reduced in the direction which connects said mixed section with said acceleration tube section.
[0026] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by having the 1st duct where said gas passes said mixed section, and the 2nd duct which spouts said liquid in the passage direction of said gas in this 1st duct.
[0027] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by having the 1st duct where said gas passes said mixed section, the 2nd duct which is arranged into this 1st duct and spouts said liquid, and the 3rd duct which is arranged into this 2nd duct and spouts said gas further.
[0028] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by being the same as that of the jet direction of said drop in the direction of the liquid which blows off from the gas which flows said 1st duct, and the 2nd duct.
[0029] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by forming more greatly than the cross section of said acceleration tube section the cross section of the gas input supplied to said mixed section.
[0030] Moreover, 2 fluid jet nozzle for washing of this invention is characterized by having a straightening vane in the jet direction of a drop, and the direction which carries out an abbreviation rectangular cross at the point of said acceleration tube section.
[0031] Furthermore, the washing station of this invention is characterized by having one of above-mentioned 2 fluid jet nozzles for washing, a gas supply means to be connected to the mixed section of said 2 fluid jet nozzle for washing, and to supply pressurization gas, and a liquid supply means to be connected to the mixed section of said 2 fluid jet nozzle for washing, and to

supply a pressurization liquid.
[0032] Moreover, the washing station of this invention is characterized by arranging the tip of the acceleration tube section of said 2 fluid jet nozzle for washing in the location distant from the washed material front face 5-50mm.
[0033] Moreover, the washing station of this invention is characterized by making into 1 - 10 kgf/cm2 the supply pressure of the gas supplied to said 2 fluid jet nozzle, and a liquid, respectively.
[0034]
[Embodiment of the Invention] The gestalt of implementation of this invention is explained about drawing below. In addition, the same sign shows a same or considerable part through each drawing.
Gestalt 1. drawing 1 of operation is the sectional view concerning the gestalt of implementation of this invention showing the structure of 2 fluid jet nozzle 10 for washing. This injects in mind the drop which mixed and formed the gas and the liquid which were pressurized, and washes by making it collide with a washed object front face. This 2 fluid jet nozzle 10 for washing consists of the mixed sections B which have the mixer tube 12 which mixes the acceleration section A which has the acceleration tube 11 which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of gas and the input 3 of a liquid which were pressurized are established in the mixer tube 12.
[0035] Between the acceleration tubes 11 at the tip of a nozzle where the description of this 2 fluid jet nozzle 10 for washing spouts a drop, i.e., a-b in drawing, is a circular straight pipe configuration, and die length is that the cross section in 30-200mm and tubing is 2 3-15mm. Moreover, it is a circular straight pipe configuration between the mixer tubes 12 with which the gas and the liquid which were pressurized are respectively mixed through piping, i.e., b-c in drawing, and it is that the cross section has the space of 2 [die length / 3-50mm] 7-100mm. Furthermore, the cross section of the input 2 of the gas supplied to said mixer tube 12 is that the cross section of 2 and the input 3 of a liquid is 2 0.01-20mm 7-200mm.
[0036] As a concrete example, the die length between a-b in drawing is [the cross section in 100mm and tubing] 2 7mm, as for the mixer tube 12, the die length between b-c in drawing has 30mm, the cross section has the space of 2 20mm, and the cross section of the input 2 of gas is [the cross section of the input 3 of 2 and a liquid of the acceleration tube 11 at the tip of a nozzle] 2 5mm 15mm.
[0037] Drawing 2 is the mimetic diagram in which having equipped with said 2 fluid jet nozzle 10 for washing, for example, showing the configuration of the washing station for semi-conductor wafers. This washing station removes the contamination which has adhered on the front face of the semi-conductor wafer 5. It connects with 2 fluid jet nozzle 10 for washing, and this washing station equips 2 fluid jet nozzle 10 for washing with gas supply means 2a which carries out pressurization supply of gas and the liquid, and liquid supply means 3a. Moreover, this equipment is equipped with the stage 6 holding the semi-conductor wafer 5, the motor 7 made to rotate a stage 6, and the process cup 8 which prevents scattering of the waterdrop at the time of washing. The exhaust port 9 is connected to the process cup 8. Moreover, 2 fluid jet nozzle 10 for washing was held, and it has the robot arm 4 to which it is made to move.
[0038] Next, actuation of this washing station is explained. The semi-conductor wafer 5 is fixed to a stage 6, and it rotates at a predetermined rotational frequency by the motor 7. The gas pressurized from gas supply means 2a and the liquid pressurized from liquid supply means 3a are supplied through the gas input 2 and the liquid input 3 in the mixer tube 12 of 2 fluid jet nozzle 10 for washing, as shown in drawing 1 . Gas and a liquid are mixed and a liquid changes to the granular drop 1 between the mixed sections B in 2 fluid jet nozzle 10 for washing, i.e., b-c in drawing of the mixer tube 12. Between a-b in drawing of the acceleration section 11 at the tip of a nozzle in 2 fluid jet nozzle 10 for washing, i.e., an acceleration tube, it is accelerated by the flow of gas, and particle size becomes still smaller and a drop 1 blows off from a nozzle tip.
[0039] As shown in drawing 2 , the spouted drop 1 collides with semi-conductor wafer 5 front face, and removes the contamination which has adhered on semi-conductor wafer 5 front face. The contamination removed from the semi-conductor wafer 5, the drop 1 which dispersed after

the surface collision of the semi-conductor wafer 5, and the gas stream which blew off from 2 fluid jet nozzle 10 for washing are discharged out of a process cup 8 from an exhaust port 9. In order to wash the semi-conductor wafer 5 whole surface at the time of washing, 2 fluid jet nozzle 10 for washing is held, and 2 fluid jet nozzle 10 for washing is horizontally moved along the front face of the semi-conductor wafer 5 by the robot arm 4 to which it is made to move.
[0040] Drawing 3 is a graph which shows the relation (flow characteristics) of the supply pressure of the gas of 2 fluid jet nozzle 10 for washing of the gestalt of this operation and the flow rate of gas in comparison with the conventional 2 fluid jet nozzle 70 for washing shown in drawing 18 . In drawing 3 , as the flow rate line 3-1 shows the quantity of gas flow of 2 fluid jet nozzle 10 for washing of the gestalt of this operation shown in drawing 1 and explained it as an example previously, the bores of the acceleration section A are [3mm (the cross section is 2 7mm) and the internal cross section of the mixed section B] the things of 2 20mm. Moreover, as the flow rate line 3-2 shows the quantity of gas flow of the conventional 2 fluid jet nozzle 70 for washing shown in drawing 18 and being previously explained as an example, for the bore of the 1st duct 72, the outer diameters of 4.35mm (the cross section is 2 15mm) and the 2nd duct 73 are [6.8mm and the internal cross section of the 1st duct 72 of the outside of the 2nd duct 73] the things of 2 6.8mm.
[0041] When the supply pressure of gas is the same, as compared with the conventional 2 fluid jet nozzle 70 for washing, as for 2 fluid jet nozzle 10 for washing of this invention, the flow rate of gas becomes large, so that drawing 3 may show. As explanation of a Prior art described this, in the conventional 2 fluid jet nozzle 70 for washing shown in drawing 18 , the 1st duct 72 is a straight pipe and the internal cross section of the 1st duct 72 through which the gas of the outside of the 2nd duct 73 passes becomes smaller than the cross section between a-b in drawing. Therefore, rate-limiting is carried out by the narrowest internal cross section [of a path] of the 1st duct of the outside of the 2nd duct 73, namely, a rate is restricted, and the flow rate of gas decreases.
[0042] Drawing 4 is a graph which shows the relation of the supply pressure of the gas of 2 fluid jet nozzle 10 for washing of the gestalt of this operation and the spray velocity of a drop in comparison with the conventional 2 fluid jet nozzle 70 for washing. In drawing 4 , a speed line 4-1 shows the spray velocity of the drop of 2 fluid jet nozzle 10 for washing of the gestalt of this operation, and a speed line 4-2 shows the spray velocity of the drop of the conventional 2 fluid jet nozzle 70 for washing. When the supply pressure of gas is the same, as compared with the conventional 2 fluid jet nozzle 70 for washing, as for 2 fluid jet nozzle 10 for washing of this invention, the spray velocity of a drop becomes quick, so that drawing 4 may show.
[0043] The bore of the acceleration tube 11 of the nozzle point of 4.35mm (the cross-sectional area is 2 15mm) and 2 fluid jet nozzle 10 for washing of this invention assumes [the bore of the nozzle point of the conventional 2 fluid jet nozzle 70 for washing] the case of 3mm (the cross-sectional area is 2 7mm) the same [with having explained previously] as a concrete example. As for the spray velocity of the drop in 2 fluid jet nozzle 10 for washing of this invention, the supply pressure of gas can become whenever [sonic] in about 3 kgf/cm2. The supply pressures of gas are about 7 kgf/cm2, and the spray velocity of the drop in the conventional 2 fluid jet nozzle 70 for washing is 224 m/sec. In order to become whenever [sonic] in the conventional 2 fluid jet nozzle 70 for washing, the supply pressure of gas is required two or more 10 kgf/cm. Therefore, as for 2 fluid jet nozzle for washing of this invention, the supply pressure of gas can raise the spray velocity of a drop with low voltage more.
[0044] Drawing 5 is a graph which shows the relation between the die length between a-b in the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing of this invention, i.e., drawing 1 of an acceleration tube 11, and the spray velocity of a drop. In 30mm or less, the spray velocity of a drop has the late die length of the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing so that drawing 5 may show. This is because the drop 1 formed in the mixed section B of 2 fluid jet nozzle 10 for washing cannot fully receive acceleration according [the acceleration section A at the tip of a nozzle] to the flow of gas since it is short. Moreover, as for the spray velocity of a drop, the die length of the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing becomes late gently in 200mm

or more. For the acceleration section A at the tip of a nozzle, since it is long, this is for the flow rate of gas to fall according to the fluid resistance force in piping. Therefore, 30-200mm is suitable for the die length of the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing.

[0045] Drawing 6 is a shown graph which showed the relation between the spray velocity of the drop of 2 fluid jet nozzle for washing, and a detergency with the elimination factor of a contamination. A detergency becomes large in proportion to the spray velocity of a drop so that more clearly than drawing 6 .

[0046] Drawing 7 is the graph which showed the relation between the flow rate of a liquid at the time of changing the cross section in tubing of the acceleration section A at the tip of a nozzle of 2 fluid jet nozzle 10 for washing of this invention, and a detergency with the elimination factor of a contamination. In drawing 7 , as for a curve 7-1, 7-2, and 7-3, the internal cross section of the acceleration tube 11 at the tip of a nozzle shows change of the detergency in 2 3mm 2 or 5mm 2 or 7mm, respectively. 2 fluid jet nozzle for washing into which this graph changed only the cross-sectional area in tubing of the acceleration section A at the tip of a nozzle — setting — the supply pressure of gas - it is made a law and the flow rate of a liquid is changed. Therefore, when the cross section in tubing of the acceleration tube 11 at the tip of a nozzle is large, the flow rate of gas increases.

[0047] When there are few flow rates of a liquid, a detergency becomes small so that it may see to drawing 7 . Since there is little number of a drop, this is because washing effectiveness fell. About 100 or more mL/min of flow rates of the liquid for obtaining sufficient elimination factor under these conditions is required. Moreover, when there are many flow rates of a liquid, a detergency becomes small gently. Since the amount of the drop which can fully accelerate this to the flow rate of a certain gas is restricted, it is because there were too many flow rates of a liquid and the rate of a drop became slow.

[0048] Moreover, when the cross section in tubing of the acceleration section A at the tip of a nozzle is small, since there are few flow rates of gas, the amount of a fully accelerable drop, i.e., the flow rate of a liquid, decreases, and an elimination factor is low. On the other hand, since ****** and the flow rate of gas have much cross section in tubing of the acceleration section A at the tip of a nozzle, the amount of a fully accelerable drop, i.e., the flow rate of a liquid, increases, and an elimination factor becomes high. However, if the cross section in tubing of a nozzle point is too large, there are many flow rates of gas, and a running cost becomes high and is not a best policy economically. Moreover, the flow rate of gas increases, it is necessary to increase the displacement for fully performing the exhaust air in a process cup 8, a running cost becomes high, and it is not a best policy economically. If these are taken into consideration, it is appropriate for the cross section in tubing of the acceleration tube 11 at the tip of a nozzle to carry out to two or more [3mm]. Moreover, as for the cross section, about [3-15mm] two are practical in practice, and according to the experiment etc., about [7mm] two become the optimal about. Furthermore, in order to make the fluid resistance force small, the configuration of the acceleration section A at the tip of a nozzle is a tube, and is desirable. [of a straight pipe]

[0049] The cross section of the nozzle mixing section B with which the gas and the liquid which were pressurized are respectively mixed through piping must be larger than the cross section in tubing of the acceleration section A at the tip of a nozzle at least. In being smaller than the cross section in tubing of the acceleration section A at the tip of a nozzle, the flow rate of gas is extracted in the mixed section B, and it does not reach the rate of the drop for obtaining sufficient detergency. Moreover, when the cross section of the mixed section B is too large, detailed-ization of the drop in the mixed section is not fully made, but washing effectiveness becomes low. If the die length of the mixed section B is short, acceleration of the drop in the mixed section B is insufficient, and sufficient detergency cannot be obtained. moreover — if the die length of the mixed section B is long — the fluid resistance force in the mixed section B — high — becoming — the flow rate of gas — few — a fence — **** — sufficient detergency cannot be obtained. Therefore, if these are taken into consideration, the cross section of the mixed section B must be larger than 2 at least the minimum value of 3mm of the suitable cross section in tubing of the acceleration section A at the tip of a nozzle, therefore two or more

[3mm] are suitable for it. Moreover, 2 is suitable 3-200mm practical. Moreover, the die length of the mixed section B has 3-50 practicalmm. In order to make the fluid resistance force small, the configuration of the mixed section B has a desirable tube further again.
[0050] The cross section of the input 2 of the gas supplied to said mixed section B is larger than the minimum part of the cross section in tubing of the acceleration section A at the tip of a nozzle at least, and must be made into the cross section of the mixing-on structure section B below equivalent so that the flow rate of gas may not be extracted. Therefore, the cross section of the gas input 2 is larger than 2 the minimum value of 3mm of the suitable cross section in tubing of the acceleration section A, and it is necessary to make it or more [at least 3mm] into two. Moreover, about [7-200mm] two are suitable practical. Moreover, the magnitude for passing the flow rate of the minimum liquid for obtaining sufficient elimination factor and about 100 mL/min or more is required for the cross section of the input 3 of a liquid. For that, also theoretically, there should just be the cross section with 2 more than of 0.04mm of the liquid input 3. Moreover, it is better not to be too large so, in order to raise detailed-izing of the drop in the mixed section B, and the initial velocity of a drop. About [0.04-20mm] two are suitable practical.
[0051] Next, the underlying concept of actuation of 2 fluid jet nozzle for washing by this invention and an operation is explained using drawing 8 . Drawing 8 is drawing for explaining the detergency by the injected drop. First, as shown in drawing 8 (a), suppose that a drop 1 collides at the rate of Vo to the front face of the semi-conductor wafer 5. Then, as shown in drawing 8 (b), the pressure P called impact pressure to the lower part of a drop 1 arises in the case of the collision of a drop 1. Next, as shown in drawing 8 (c), the flow Vf called a horizontal radiation style arises by this impact pressure. Furthermore, a drop 1 deforms, as shown in drawing 8 (d), and the contamination on the semi-conductor wafer 5 is removed by the force received from impact pressure P or this radiation style Vf.
[0052] Impact pressure P is given by the following formula.
[Equation 1]

$$P = \frac{1}{2}\alpha\rho_L C_L V_0 \quad \cdots\cdots\cdots (1)$$

Vo expresses among the formula the reduction multiplier which a collision rate and rhoL show alpha by the consistency of a liquid, and shows CL by the degree type whenever [in a liquid / acoustic-velocity].
[Equation 2]

$$\alpha = \frac{0.41}{1 + 0.59\left(\rho_L C_L / \rho_s C_s\right)} \quad \cdots\cdots (2)$$

rhos expresses the consistency of a semi-conductor wafer substrate among a formula, and Cs expresses whenever [in a semi-conductor wafer substrate / acoustic-velocity].
[0053] The rate Vf of a radiation style is expressed with a degree type.
[Equation 3]

$$V_f = \left(\alpha C_L V_0\right)^{1/2} \quad \cdots\cdots\cdots (3)$$

[0054] If the contamination on the semi-conductor wafer 5 is made into globular form particle, the external force (the removal force or detergency) D which this particle receives is expressed with a degree type.
[Equation 4]

$$D = C_D \frac{\rho_L}{2} V_f^2 \frac{\pi}{4} d^2 \quad \cdots\cdots\cdots (4)$$

[Equation 5]

$$D = C_D P \frac{\pi}{4} d^2 \quad \cdots\cdots\cdots (5)$$

CD expresses a drag coefficient among a formula and d expresses the diameter of particle. In

addition, although a form is different, as for [a formula 4] and [a formula 5], the value same as a result is acquired. The detergency D is proportional to the collision rate Vo of a drop, and if the collision rate Vo is gathered, a detergency D will become large so that it may understand from now on.

[0055] Although it does not depend for a detergency D on the particle size of a drop 1, the area (this affects the elimination factor of a contamination) with which a drop 1 collides changes. the amount of supply of a liquid – if particle size of a drop 1 is made small when it considers as a law, the number of a drop 1 will increase in inverse proportion to the cube of particle size, and, on the other hand, the area with which one drop collides will decrease in proportion to the square of particle size. The area with which the whole drop collides increases as a result, and a cleaning effect increases. Moreover, this model is applicable not only to the so-called particle of a drop and a liquid but the ice grain child in ice scrubber washing which is a Prior art. In the case of a ice grain child, whenever [in a ice grain child / acoustic-velocity], since CL is larger than whenever [in liquids, such as water / acoustic-velocity], when a collision rate is the same, it becomes larger [a ice grain child's detergency] than a drop.

[0056] Although the above-mentioned model assumes the case where a drop 1 collides perpendicularly to the front face of the semi-conductor wafer 5, since a certain include angle is given, [a formula 4] and [a formula 5] are respectively expressed with a degree type in fact.

[Equation 6]

$$D = C_D \frac{\rho_L}{2} V_f^2 \frac{\pi}{4} d^2 \sin(\theta) \quad \cdots\cdots (6)$$

[Equation 7]

$$D = C_D P \frac{\pi}{4} d^2 \sin(\theta) \quad \cdots\cdots (7)$$

theta expresses the collision include angle of the drop 1 with the direction of semi-conductor wafer 5 front face among the formula.

[0057] Drawing 9 is the graph which showed the relation between the collision include angle of a drop, and a detergency with the elimination factor of a contamination. If the collision include angle of a drop is ******(ed) as shown in drawing 9 , according to a sign curve, a detergency will become large.

[0058] Drawing 10 is a graph which shows the relation of the particle size and the elimination factor of the particle in the various washing approaches. Washing by 2 fluid jet nozzle 70 for washing of the former [Rhine / 10-2 / washing according / Rhine 10-1 in drawing / to 2 fluid jet nozzle 10 for washing of this invention and / in drawing] and Rhine 10-3 in drawing are curves which show the elimination factor by the conventional high-pressure jet backwashing by water. In addition, although ice scrubber washing which is a Prior art is not indicated, it is comparable as Rhine 10-1. In high-pressure jet backwashing by water of Rhine 10-3 in drawing, particle 1 micrometer or less is unremovable as shown in drawing 10 . Moreover, in washing by the conventional 2 fluid jet nozzle 70 for washing of Rhine 10-2 in drawing, although a detergency is higher than high-pressure jet backwashing by water, 0.1-micrometer particle is unremovable. On the other hand, washing by 2 fluid jet nozzle 10 for washing of this invention of Rhine 10-1 in drawing has a detergency higher than these, and removal of particle 0.1 micrometers or less is possible for it.

[0059] In addition, with the gestalt of the above-mentioned implementation, although the semi-conductor wafer was illustrated as a substrate, this invention is not restricted to this, and also when removing the contamination which has adhered on the front face of substrates, such as liquid crystal and a photo mask, it can be applied.

[0060] Gestalt 2. drawing 11 of operation is the sectional view of 2 fluid jet nozzle 20 for washing concerning the gestalt of other operations of this invention. This 2 fluid jet nozzle 20 for washing consists of the mixed sections B containing the mixer tube 22 which mixes the acceleration section A which consists of an acceleration tube 21 which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of the pressurized gas and the side attachment wall of the mixer tube 22 are penetrated, the input 3 of

a liquid carries out opening into the mixer tube 22, and the inhalant canal 23 of the liquid with which a part for the point has been arranged the mixer tube 22 and in the shape of the same axle is formed in the mixer tube 22.
[0061] The description of this 2 fluid jet nozzle 20 for washing is as follows. Between c-d in drawing of the mixed sections B (between b-d in drawing) with which the gas and the liquid which were pressurized are mixed It has the structure of double tubing where gas flows to an outer tube (the 1st duct 22), and a liquid flows to an inner tube (the 2nd duct 23), like the Prior art. As a difference The internal cross section of the 1st duct 22 of the outside of the 2nd duct 23 through which the gas of this part passes is a larger point than the cross section of the acceleration tube 11 (between a-b in drawing) at the tip of a nozzle. Therefore, since rate-limiting [of the double tubing in the mixed section B] is not carried out by the way, namely, a rate is not restricted and a large flow rate is obtained with a supply pressure lower than the conventional 2 fluid jet nozzle 70 for washing, the spray velocity of gas of a drop is quick and its detergency is high.
[0062] Moreover, another description of this 2 fluid jet nozzle 20 for washing is the point from the outlet of the 2nd duct 23 in the mixed section B, it is until it connects with an acceleration tube 21 (between b-c in drawing), and it is the point that the 1st duct 22 is becoming thin gradually to the cross section of an acceleration tube 21. Thereby, the rate of the gas between b-c in drawing becomes quick gradually, without receiving loss of the fluid resistance force. From the outlet 3 of the 2nd duct 23, it is gradually accelerated by the flow of this gas, and the breathed-out drop 1 is made detailed more. Therefore, the particle size of a drop 1 is small, and the spray velocity of a drop 1 becomes quick and a detergency is higher than 2 fluid jet nozzle 10 for washing of the gestalt of operation shown in drawing 1 .
[0063] As a concrete example of this 2 fluid jet nozzle 20 for washing The die length of the acceleration section A at the tip of a nozzle (between a-b in drawing) is [the cross section in 100mm and tubing] 2 7mm. For the cross section of the part into which the gas of the outside of the 2nd duct 23 between 20mm and c-d in drawing flows [the die length between b-c in drawing of the mixed section B (between b-d in drawing) / the die length between 20mm and c-d in drawing], the cross section of the input 2 of 2 and gas is [the cross section of the input 3 of 2 and a liquid] 2 3mm 20mm 20mm. Furthermore, the 1st duct 22 and 2nd duct 23 are [both] a tube configuration, and are arranged in the c section in drawing of the mixed section B concentric circular. Thus, by constituting, a drop is made detailed more and the spray velocity of a drop can realize high 2 fluid jet nozzle for washing of a detergency quickly therefore.
[0064] Gestalt 3. drawing 12 of operation is the sectional view of 2 fluid jet nozzle 30 for washing concerning the gestalt of other operations of this invention. This 2 fluid jet nozzle 30 for washing consists of the mixed sections B (b-d in drawing) containing the mixer tube 32 which mixes the acceleration section A (a-b in drawing) which consists of an acceleration tube 31 which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of the pressurized gas and the side attachment wall of the mixer tube 32 are penetrated, the input 3 of a liquid carries out opening into the mixer tube 32, and the inhalant canal 33 of the liquid with which a part for the point has been arranged the mixer tube 32 and in the shape of the same axle is formed in the mixer tube 32. Furthermore, the inhalant canal 34 of gas is arranged in the shape of the same axle in the inhalant canal 33 of this liquid, and it has 3 detonator structures. The acceleration section A at between b-c in drawing of the mixed section B after the gas and the liquid which were pressurized were mixed, and the tip of a nozzle (between a-b in drawing) is the same as the gestalt of operation of drawing 11 .
[0065] The description of this 2 fluid jet nozzle 30 for washing is as follows. Namely, this 2 fluid jet nozzle 30 for washing The 1st duct 32 where gas passes through the inside of it between c-d in drawing of the mixed section B, The 2nd duct 33 where the side attachment wall of the 1st duct 32 is penetrated, the point is prolonged even in the 1st duct 32, and a liquid passes through the inside of it from the outside of the 1st duct 32, Furthermore, from the outside of the 2nd duct 33, the side attachment wall of the 2nd duct 33 was penetrated, the point was prolonged even in the 2nd duct 33, and it has the 3rd duct 34 where gas passes through the inside of it. Moreover, the point of the 3rd duct 34 and the point of the 2nd duct 33 are prolonged in the

same direction as the direction where the 1st duct 32 extends.
[0066] The internal cross section of the 1st duct 32 of the outside of the 2nd duct 33 through which the part of this 3 detonator structure and the gas between c-d in drawing pass is larger than the cross section of the acceleration section A at the tip of a nozzle (between a-b in drawing) like the gestalt of operation shown in drawing 11 . In the point of the 3rd duct 34, the gas which came out from the 3rd duct 34, and the liquid which flows the inside of the 2nd duct 33 are mixed, a drop is formed, and detailed-ization of a drop is further promoted by the flow of gas in the 1st duct 32.
[0067] The drop more detailed than the drop by 2 fluid jet nozzle for washing of the gestalt of operation shown by drawing 1 or drawing 11 as a result is obtained, and the spray velocity of a drop becomes quick. As a concrete example, the particle size of the drop in the conventional 2 fluid jet nozzle 70 for washing About 20 micrometers, The particle size of the drop in 2 fluid jet nozzle 10 for washing of the gestalt of operation shown by drawing 1 About 10 micrometers, The particle size of the drop in 2 fluid jet nozzle 30 for washing of the gestalt of this operation which the particle size of the drop in 2 fluid jet nozzle 20 for washing of the gestalt of operation shown by drawing 11 showed by about 5 micrometers and drawing 12 is about 2 micrometers.
Therefore, the detergency in 2 fluid jet nozzle 30 for washing of the gestalt of this operation of the conventional 2 fluid jet nozzle 70 for washing is higher than 2 fluid jet nozzle for washing of the gestalt of operation shown by drawing 1 or drawing 11 from the first.
[0068] Gestalt 4. drawing 13 of operation is the sectional view concerning the gestalt of other operations of this invention showing the structure of 2 fluid jet nozzle 40 for washing. This 2 fluid jet nozzle 40 for washing consists of the mixed sections B (b-d in drawing) containing the mixer tube 42 which mixes the acceleration section A (a-b in drawing) which consists of an acceleration tube 41 of the Laval-nozzle configuration which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of gas and the input 3 of a liquid which were pressurized are established in the mixer tube 42. The configuration between b-c in drawing of the duct 42 of the mixed section B where the gas and the liquid which were pressurized are mixed is the same as the 1st duct 22 of the gestalt of operation shown by drawing 11 , and the configuration between c-d in drawing of the duct 42 of the mixed section B is the same as the configuration between b-c in drawing of the mixed section B of the gestalt of operation shown by drawing 1 .
[0069] The description of 2 fluid jet nozzle 40 for this washing is the point that the bore of the acceleration section A at the tip of a nozzle (between a-b in drawing) is the Laval-nozzle configuration which becomes large gradually toward the exhaust nozzle of a drop. 30-200mm is suitable for the die length of the acceleration section A at the tip of a nozzle of this 2 fluid jet nozzle 40 (between a-b in drawing) at the same reason as the case of the straight pipe of the gestalt 1 of operation. Moreover, the cross section is the minimum converging section (throat section), i.e., the b section in drawing, and is [two or more / 3mm] required for the cross section in tubing of the acceleration section A at the same reason as the case of the straight pipe of the gestalt 1 of operation. Moreover, about [3-10mm] two are suitable practical. Furthermore, at least, the cross section of the outlet section, i.e., the a section in drawing, is larger than a converging section, and required. [two or more / 3mm] About [6-20mm] two are suitable practical.
[0070] Although it is for a Laval nozzle (Laval nozzle) accelerating gas at a supersonic speed in a duct at - **, 2 fluid jet nozzle 40 for this washing is optimizing the configuration in order to make a drop accelerate to a supersonic speed. When [which needs about 100 or more mL/min of flow rates of the liquid for obtaining sufficient elimination factor] there are many flow rates of a liquid, a running cost becomes high, and as seen to drawing 7 , since it is not a best policy economically, the flow rate of the optimal liquid is 100 - 300 mL/min. The minimum quantity of gas flow for accelerating the drop of this flow rate to a supersonic speed is 200 - 600 L/min.
[0071] In order to obtain this quantity of gas flow in the range to a maximum of 7 kgf/cm2 which is the supply pressure of the gas usually used, the cross section of the converging section (throat section) of the acceleration tube 41 of 2 fluid jet nozzle 40 and the b section in drawing must be carried out more than 2 or it 3-10mm. Moreover, since a drop is accelerable to a

supersonic speed if the cross section of the outlet section of the acceleration tube 41 of 2 fluid jet nozzle 40 and the a section in drawing is made into twice the cross section of a converging section (throat section), the optimum value of the cross section of the outlet section is set to 2 6-20mm. In 2 fluid jet nozzle 40 of this condition, the spray velocity of a drop 1 reaches about 500 about 1.5 times as much m/sec as whenever [sonic]. Since this 2 fluid jet nozzle 40 can spout a drop 1 at a supersonic speed as mentioned above, its detergency is higher than ice scrubber washing, the conventional 2 fluid jet nozzle 70, and 2 fluid jet nozzle of the gestalt of operation further shown by drawing 1 , drawing 11 , or drawing 12 .

[0072] Gestalt 5. drawing 14 of operation is the sectional view showing the structure of 2 fluid jet nozzle 50 for washing of this invention which starts the gestalt of other operations further. This 2 fluid jet nozzle 50 for washing consists of the mixed sections B (b-d in drawing) containing the mixer tube 52 which mixes the acceleration section A (a-b in drawing) which consists of an acceleration tube 51 which aims at acceleration of a drop in the part at the tip of a nozzle, the pressurized gas, and a liquid, and forms a drop. The input 2 of gas and the input 3 of a liquid which were pressurized are established in the mixer tube 52. The configuration of the mixed section B (between b-c in drawing) where the acceleration section A (between a-b in drawing), the pressurized gas, and the liquid at the tip of a nozzle are mixed is the same as the gestalt of operation shown in drawing 1 .

[0073] The description of 2 fluid jet nozzle 50 for this washing is a point equipped with the straightening vane 55 which controls the direction of the jet of the drop which blew off, and gas between a-b in the outlet of the acceleration section A at the tip of a nozzle, the a section in drawing, or drawing. This straightening vane 55 spreads [at the jet direction and a right angle / in 10-100mm] from the acceleration tube 51 of 2 fluid jet nozzle 50 for washing and is monotonous.

[0074] Drawing 15 is the mimetic diagram in which having equipped with the aforementioned 2 fluid jet nozzle 50 for washing, for example, showing the configuration of the washing station for semi-conductor wafers. This washing station equips 2 fluid jet nozzle 50 for washing with gas supply means 2a which carries out pressurization supply of gas and the liquid, and liquid supply means 3a. Moreover, this equipment is equipped with the stage 6 holding the semi-conductor wafer 5, the motor 7 made to rotate a stage 6, and the process cup 8 which prevents scattering of the waterdrop at the time of washing. The exhaust port 9 is connected to the process cup 8. Moreover, 2 fluid jet nozzle 10 for washing was held, and it has the robot arm 4 to which it is made to move. Said straightening vane 55 is arranged in the location distant from semi-conductor wafer 5 front face 5-50mm, and it is arranged so that it may spread in parallel mostly with the front face of a semi-conductor wafer.

[0075] As an example, as shown in drawing 14 and drawing 15 , a straightening vane 55 is the disk with a radius of 50mm attached at the tip of a nozzle outlet. In order to be arranged at right angles to the location where 2 fluid jet nozzle 50 for washing separated from semi-conductor wafer 5 front face 20mm at the time of washing and to wash the whole front face of the semi-conductor wafer 5, horizontal migration is carried out along a front face. That is, the straightening vane 55 is arranged in parallel with the front face of the semi-conductor wafer 5, and the location distant 20mm.

[0076] Although the flow (jet) of the drop 1 which blew off from 2 fluid jet nozzle 50 for washing, and gas once tends to collide with the front face of the semi-conductor wafer 5 and tends to disperse upwards, a straightening vane 55 distributes it along the front face of ********** and the semi-conductor wafer 5. Although the jet immediately after blowing off from 2 fluid jet nozzle 50 for washing is high-speed, the jet around a straightening vane 55 becomes a low speed according to the rectification effectiveness of a straightening vane 55. Although the die length of the acceleration section A at the tip of a nozzle (between a-b in drawing) is [the cross section in 100mm and tubing] 2 7mm, and the rates of the jet immediately after blowing off are 330 m/sec of whenever [sonic] as a concrete example when the flow rate of 150 L/min and a liquid is made into 100 mL/min for the flow rate of gas, the rate of the jet around a straightening vane 55 serves as 0.4 m/sec.

[0077] When there is no straightening vane, it reflects from the front face of the semi-conductor

wafer 5, and the flow (jet) of the drop which blew off from 2 fluid jet nozzle for washing, and gas disperses upwards. After the contamination adhering to the front face of the semi-conductor wafer 5 disperses upwards with a drop, it adheres to the front face of the semi-conductor wafer 5, and makes the semi-conductor wafer 5 pollute, although - ** is removed from the front face of the semi-conductor wafer 5 by the collision of a drop. Therefore, when there is no straightening vane 55, in order to eliminate promptly the flow (jet) of the drop which blew off from 2 fluid jet nozzle 50 for washing, and gas, and the removed contamination from the front face of the semi-conductor wafer 5, the jet include angle of 2 fluid jet nozzle for washing is made into 60 degrees or less, and the large flow rate is exhausted in this and the location which countered.

[0078] Since the above-mentioned problem is solved by having a straightening vane 55, it is possible to make the jet include angle of 2 fluid jet nozzle for washing into 90 degrees (perpendicular direction), and a detergency becomes high. Moreover, since the rate of a jet is made late near the straightening vane 55, it is possible to lessen displacement. In the case of the conventional 2 fluid jet nozzle 70 for washing explained by drawing 18 , displacement is specifically required more than about 5m3/min, but in the case of 2 fluid jet nozzle 50 for washing of this invention, below 2m3/min are enough.

[0079] If it approaches not much from the front face of the semi-conductor wafer 5, since ****** will become small about scattering of a jet even in ** if the location of a straightening vane 55 separates from the front face of the semi-conductor wafer 5 not much, and the fluid resistance force of the gas which flows between a straightening vane 55 and the front faces of the semi-conductor wafer 5 will become large, the spray velocity of a drop becomes slow. For this reason, the place distant from the front face of the semi-conductor wafer 5 5-50mm of the location of a straightening vane 55 is the optimal.

[0080] Moreover, if the diameter of the configuration of a straightening vane 55 is small in the case of a disk like the gestalt of this operation, even in **, ****** will become small about scattering of a jet, and if the diameter is not much large, anchoring on a realistic equipment configuration and migration with the robot arm 4 will become difficult. For this reason, when the configuration of a straightening vane 55 is a disk, 10-100mm is suitable for that radius practical.

[0081] Gestalt 6. drawing 16 of operation is the sectional view showing the structure of 2 fluid jet nozzle 60 for washing of this invention which starts the gestalt of other operations further. The gestalt of this operation shows the nozzle which has the straightening vane which deformed. This 2 fluid jet nozzle 60 for washing consists of the acceleration section A (a-b in drawing) which consists of an acceleration tube 61, the mixed section B containing the mixer tube 62 (b-d in drawing), and a straightening vane 65 formed at the tip of an acceleration tube 61. The input 2 of gas and the input 3 of a liquid which were pressurized are established in the mixer tube 52. The configuration of the mixed section B (between b-c in drawing) where the acceleration section A (between a-b in drawing), the pressurized gas, and the liquid at the tip of a nozzle are mixed is the same as the gestalt of operation shown in drawing 14 . They are the straightening vane 65 when drawing 16 (b) looks at the sectional view of the straightening vane 65 of a direction perpendicular to the space of drawing 16 (a) to the injection direction and hard flow of a drop and drawing 16 (c) looks at a nozzle 60, and drawing of the end face of an acceleration tube 61.

[0082] It has the configuration of the core box in which only one side face carried out opening while carrying out opening of the straightening vane 65 with which this 2 fluid jet nozzle 60 for washing is equipped in the injection direction of a drop. Opening of while was carried out, and as a side face is turned to in the direction of an exhaust port, it is used for it. In this case, the rate of the jet which blew off from 2 fluid jet nozzle 60 for washing becomes slow near a straightening vane 65 according to the rectification effectiveness of a straightening vane 65, and most jets flow toward an exhaust port 9 from the side face of the method of one to which opening of the straightening vane 65 was carried out. For this reason, it is possible for exhaust air effectiveness to improve further and to lessen displacement. As mentioned above, since exhaust air effectiveness improves by forming the straightening vane which stops the jet of the gas reflected from washed material, such as a semi-conductor substrate, and a drop in the tip of a

nozzle, or its near, the displacement of a washing station can raise cleaning effect sufficient at least.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the structure of 2 fluid jet nozzle for washing concerning the gestalt 1 of implementation of this invention.
[Drawing 2] It is the mimetic diagram showing the configuration of the washing station equipped with 2 fluid jet nozzle for washing of the gestalt of implementation of this invention.
[Drawing 3] It is the graph which shows the relation (flow characteristics) between the supply pressure of the gas of 2 fluid jet nozzle for washing, and the flow rate of gas.
[Drawing 4] It is the graph which shows the relation between the supply pressure of the gas of 2 fluid jet nozzle for washing, and the spray velocity of a drop.
[Drawing 5] It is the graph which shows the relation between the die length of the acceleration section at the tip of a nozzle of 2 fluid jet nozzle for washing of this invention, and the spray velocity of a drop.
[Drawing 6] It is the graph which shows the relation between the spray velocity of the drop of 2 fluid jet nozzle for washing, a detergency, or the elimination factor of a contamination.
[Drawing 7] It is the graph which shows the relation between the flow rate of a liquid at the time of changing the cross section in tubing of the acceleration section at the tip of a nozzle of 2 fluid jet nozzle for washing of this invention, and the elimination factor of a contamination.
[Drawing 8] It is drawing for explaining the underlying concept of actuation of 2 fluid jet nozzle for washing of this invention, and an operation.
[Drawing 9] It is the graph which shows the relation between the collision include angle of the drop of 2 fluid jet nozzle for washing, a detergency, or the elimination factor of a contamination.
[Drawing 10] It is the graph which shows the relation of the particle size and the elimination factor of the particle in the various washing approaches.
[Drawing 11] It is the sectional view concerning the gestalt 2 of implementation of this invention showing the structure of 2 fluid jet nozzle for washing.
[Drawing 12] It is the sectional view concerning the gestalt 3 of implementation of this invention showing the structure of 2 fluid jet nozzle for washing.
[Drawing 13] It is the sectional view concerning the gestalt 4 of implementation of this invention showing the structure of 2 fluid jet nozzle for washing.
[Drawing 14] It is the sectional view of 2 fluid jet nozzle for washing concerning the gestalt 5 of implementation of this invention.
[Drawing 15] It is the mimetic diagram showing the configuration of the washing station equipped with 2 fluid jet nozzle for washing concerning the gestalt of implementation of this invention.
[Drawing 16] It is the sectional view showing the structure of 2 fluid jet nozzle for washing which has the straightening vane which deformed concerning the gestalt 6 of implementation of this invention.
[Drawing 17] It is the mimetic diagram of the conventional high-pressure jet water washing station.
[Drawing 18] It is the sectional view of the conventional 2 fluid jet nozzle for washing.
[Drawing 19] It is the mimetic diagram of the washing station equipped with the conventional 2 fluid jet nozzle for washing.

[Description of Notations]
10, 20, 30, 40, 50, 60 2 fluid jet nozzle for washing, 11, 21, 31, 41, 51, 61 An acceleration tube, 12, 22, 32, 42 and 52, the 62 mixer tube (the 1st duct), 23 33 The 2nd duct, 34 The 3rd duct, 55, 65 straightening vanes, 2 Gas input, 3 Liquid input, 2a A gas supply means, 3a A liquid supply means, A The acceleration section, B The mixed section.

[Translation done.]

* NOTICES *

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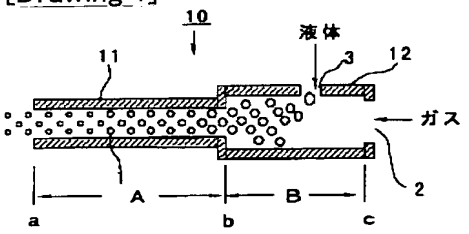
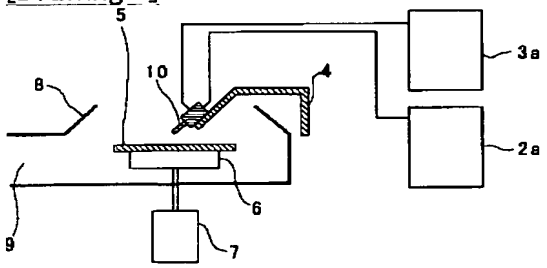
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

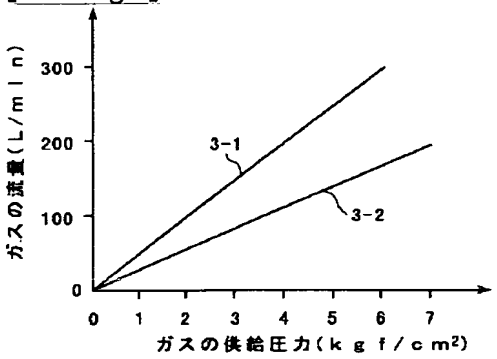
[Drawing 1]



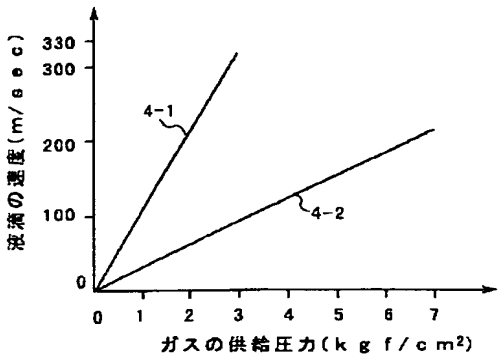
[Drawing 2]



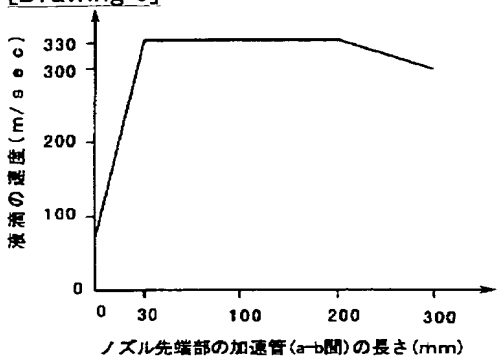
[Drawing 3]



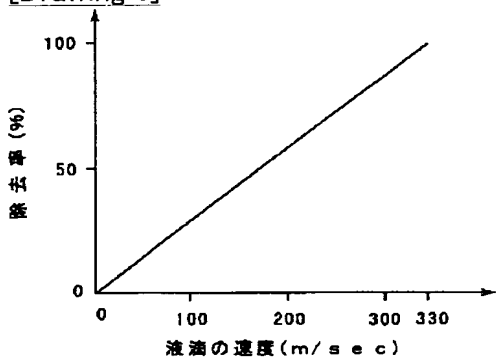
[Drawing 4]



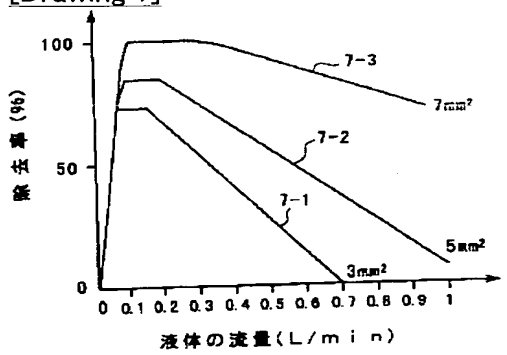
[Drawing 5]



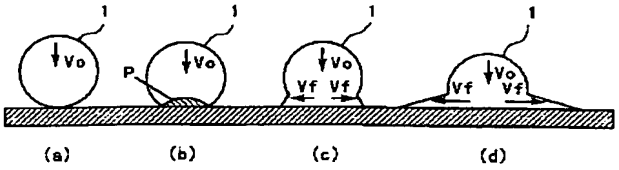
[Drawing 6]



[Drawing 7]

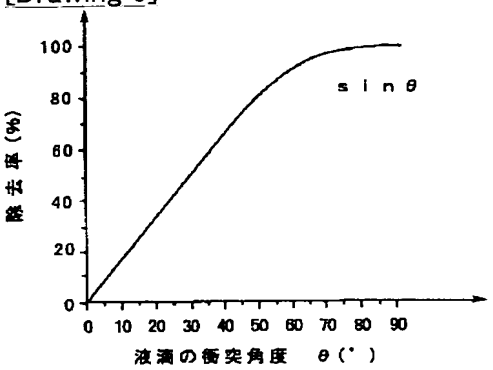


[Drawing 8]

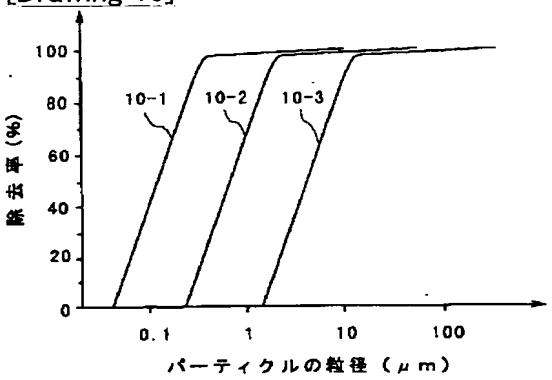


(a) 液滴粒子の基板への衝突（衝突速度:Vo）
(b) 液粒子内の圧力上昇（衝撃圧:P）
(c) 液粒子の変形、水平方向への運動（放射流:Vfの発生）
(d) 汚染物への連続的外力の発生、汚染物の移動（除去）

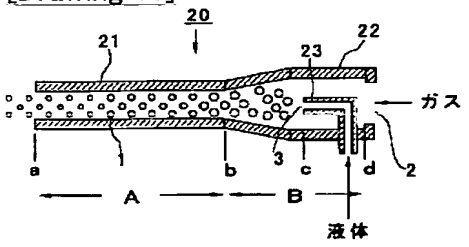
[Drawing 9]



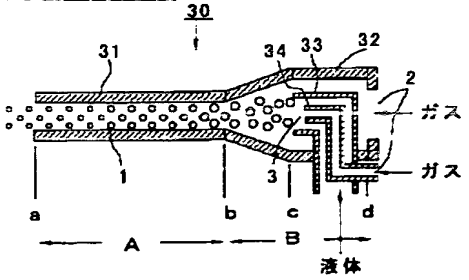
[Drawing 10]



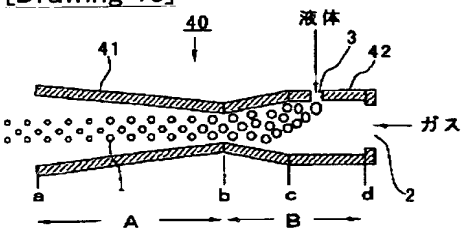
[Drawing 11]



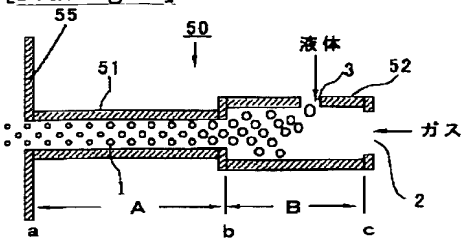
[Drawing 12]



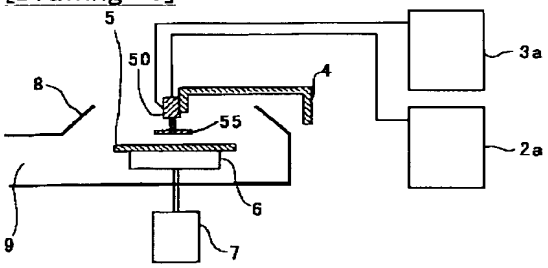
[Drawing 13]



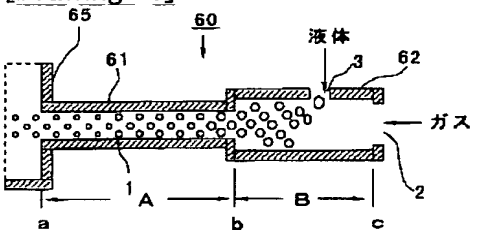
[Drawing 14]



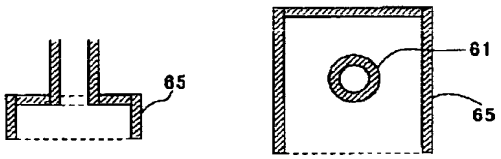
[Drawing 15]



[Drawing 16]

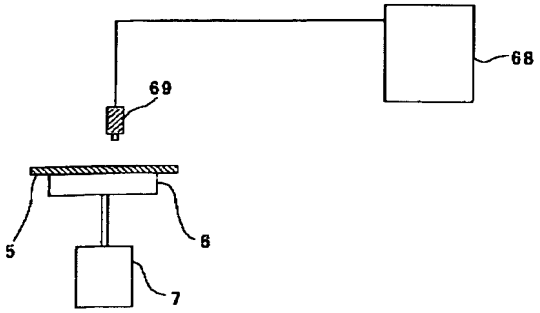


(a)

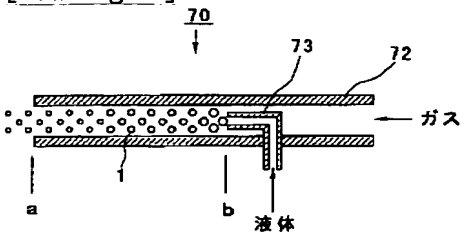


(b) (c)

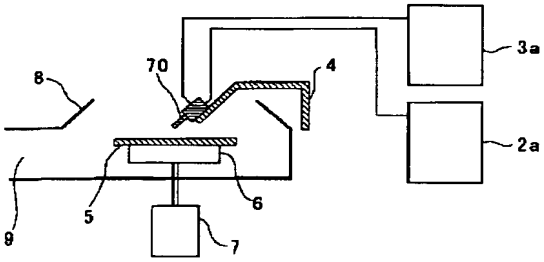
[Drawing 17]



[Drawing 18]



[Drawing 19]



[Translation done.]